SUGARBEET RESEARCH

2001 REPORT

FOREWARD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning research by U.S. Department of Agriculture, Agricultural Research Service investigators and other cooperators who are engaged in sugarbeet research. The report was assembled and produced at the expense of the Beet Sugar Development Foundation, and is for the sole use of its members and the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. This report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor and the Beet Sugar Development Foundation.

The report presents results of investigations strengthened by contributions received under Cooperative Agreement between the USDA Agricultural Research Service and the Beet Sugar Development Foundation, along with the California Beet Growers Association, the Western Joint Research Committee, and the Sugarbeet and Education Board of Minnesota and North Dakota.

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SUGARBEET RESEARCH

2001 REPORT

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U.S. Agricultural Research Station, Salinas, California

Dr. R.T. Lewellen, Geneticist
Dr. H.Y. Liu, Plant Pathologist
Dr. W.M. Wintermantel, Plant Pathologist
Dr. M.H. Yu, Geneticist
Dr. J.E. Duffus, Collaborator

Cooperation:

- Holly Sugar Company
- Spreckels Sugar Division
- California Beet Growers Association
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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 2001

BIANCARDI, E., R.T. LEWELLEN, M. DeBIAGGI, A.W. ERICHSEN and P. STEVANATO. 2002. The origin of rhizomania resistance in sugar beet. Eyphytica. In press.

In the last 35 years, breeding has greatly reduced the damages caused by rhizomania in sugar beet crops. After the first encouraging results using the Alba genotypes, the cultivar Rizor represented a substantial step forward and has given good yield improvement in diseased fields in many parts of the world. The original variety and subsequent improved versions continued to offer good performances for about a decade, after which it was surpassed by other hybrids derived in part from the Rizor itself. Further progress in terms of sugar production became possible in 1986 when the Holly monogerm lines were released in USA and Europe. In spite of the incomplete information about the genealogy of the first resistant materials, many evidences and the molecular analyses on the different genotypes suggest a possible common porgenitor and lineage. The resistant cultivars have kept the yield at an adequate level, allowing cultivation to continue in countries where the disease has reached epidemic proportions. The case of rhizomania resistance in sugar beet can therefore be considered as one of the most important achievements in plant breeding.

GALLIAN, J.J., W.M. WINTERMANTEL, and P. B. HAMM. First Report of Rhizomania of Sugar Beet in the Columbia River Basin of Washington and Oregon. Plant Disease 86 (1): 72.

Rhizomania, caused by *Beet necrotic yellow vein virus* (BNYVV) and vectored by the soil-borne fungus *Polymyxa betae* Keskin, is one the most economically damaging diseases affecting sugar beets (*Beta vulgaris* L.) world wide, and has been found in most sugar beet growing areas of the United States (2). During harvest in October, 2000, sugar beets exhibiting typical symptoms of rhizomania (1) were found in a field near Paterson, WA. Sugar beets had been planted in the field for two consecutive years in 1999 and 2000, but prior to 1999 the field had not been planted with sugar beets for approximately 20 years. Symptomatic roots from the field were stunted, with vascular discoloration and a proliferation of lateral rootlets. Leaves were chlorotic. Four soil samples were taken from areas of the field exhibiting symptoms. Each sample was split, then diluted with an equal amount of sterile sand. Seeds of rhizomania-susceptible sugar beet variety Beta 8422 were planted in the soil/sand mix, and were maintained in a controlled environment at 24 C and 12 hr day-length at one location and in the greenhouse at another. After eight weeks ELISA was performed on roots of plants grown at each location. Triple-antibody sandwich (TAS) ELISA (Agdia, Inc., Elkhart, Indiana) was conducted at the University of Idaho, and double-antibody sandwich (DAS) ELISA was performed at the USDA-ARS with antiserum specific for BNYVV (2). Two of the four samples were positive for BNYVV in the ELISA tests at both locations, based on absorbance values at least three times those of healthy controls. Again, in July 2001, TAS-ELISA tests were conducted on roots sampled from a field in Washington, 12.9 km from the first field, as well as from a field across the Columbia River near

Boardman, OR. Samples from both fields tested positive for BNYVV. All three fields are within 24 km of one another. Four additional fields have subsequently been confirmed in this region, based on symptomology and ELISA. There are approximately 3240 ha of sugar beets grown in the region, and growers have been advised as a result of this confirmation to plant resistant varieties and increase the sugar beet rotation interval with non-host crops to a minimum of four years.

KAFFKA, S.R., R.T. LEWELLEN, and W.M. WINTERMANTEL. 2002. Curly top threatens growers in the San Joaquin Valley. The California Sugarbeet, 2001 Annual Report, pages 14-25.

Beet curly top virus (BCTV), a Gemini virus, remains a problem for farmers in the San Joaquin Valley of California. It is spread by the beet leaf hopper (*Circulifer tenellus* Baker), which has become naturalized in the San Joaquin Valley of California. Recent dependence on non-tolerant sugar beet cultivars has led to increased concern about the potential for a BCTV epidemic. Two trials were carried out in successive years in the western San Joaquin Valley to test the effects of alternative protective insecticides for control of BCTV on susceptible and tolerant (resistant) sugar beet cultivars. Two rates of imidicloprid applied as a seed treatment (45g and 90g a.i. per 100,000 seeds) were compared to the current standard treatment of phorate applied to soil at 83.8g a.i. per 1000m of row, and an untreated control. Complete natural BCTV infection occurred in both years, but the second trial took place during a major beet leaf hopper population increase and infection occurred much earlier in crop development. Sugar beet root and sugar yields declined linearly with increasing rates of infection ($r^2 = 0.856$). Yields declined because roots were significantly smaller with the non-tolerant cultivar. Sugar percentage was unaffected by treatments, but differed by cultivar. Imidicloprid and phorate provided similar levels of protection to the tolerant cultivar, and some protection to the resistant cultivar if infection occurred later in crop development. Neither provided protection when susceptible seedlings were infected with BCTV. Changes in land use in the San Joaquin Valley combined with recent adoption of high yielding but non-tolerant cultivars threaten the viability of sugar beet production in affected areas.

LEWELLEN, R.T. 2001. Population improvement within multigerm, self-fertile random-mated breeding lines of sugarbeet. J.Sugar Beet Research. 38:84.

Population improvement in sugarbeet has been a major breeding objective at Salinas. In addition to improvement within conventional self-sterile (S^sS^s), open-pollinated breeding lines, self-fertile (S^f), genetic-male-sterile (aa) facilitated, random-mated populations have been developed. One distinct advantage of these self-fertile populations is that S_o (Aa) plants can be easily self-pollinated to produce sufficient S_1 seed for progeny testing and recurrent selection procedures. These S_1 lines have been evaluated per se and/or testcrossed to evaluate hybrid performance. Selected lines can be both recombined through genetic-male-sterile segregants to produce improved synthetic populations and increased in bulk or by selfing to test as potential parental lines. Disease resistance has been a primary objective. In addition, improvement for sugar yield combining ability has been attempted. From base population 931, subpopulations and synthetics have been developed for several objectives. From these sources, S_1 progenies have been

evaluated in replicated field trials. Selected S_1 lines have been recombined and/or individually testcrossed to evaluate hybrid performance. Genetic variability and improvements have been demonstrated for resistance to diseases and bolting and for components of sugar yield. Under relatively nondiseased conditions at Salinas and Brawley in 2000, population 931 had higher sugar yield than most open-pollinated lines and its sugar yield was equal to the mean of four commercial hybrid checks. In other tests, experimental hybrids with population 931 were about 95% of the mean for the commercial hybrids. Sugar yield for testcross hybrids from a set of 32 selected S_1 lines ranged from 87-119% of the mean for four commercial hybrids. The experiences and potential of self-fertile, random-mated populations in sugarbeet breeding will be discussed.

LEWELLEN, R.T. 2002. Registration of High Sucrose, Rhizomania Resistant Sugarbeet Germplasm Line CZ25-9. Crop Sci. 42:320-321.

Sugarbeet (*Beta vulgaris* L.) germplasm line CZ25-9 (Reg. no. GP-219, PI 615520) was selected by the USDA-ARS in cooperation with the Beet Sugar Development Foundation, and the California Beet Growers Association. This line was released in 2001. CZ25-9 is a high sucrose concentration, narrowly based, multigerm (MM), self-fertile (S^f), red hypocotyl (RR), diploid line that segregates for genetic male sterility (aa). It segregates for the *Rz* allele for resistance to rhizomania, caused by *Beet necrotic yellow vein virus*. In tests at Salinas and Brawley, CA, CZ25-9 had an intermediate to moderately susceptible reaction to sugarbeet *Erwinia*, powdery mildew caused by *Erysiphe polygoni* DC, *Beet curly top virus*, and *Beet yellows virus*. It is intermediate in bolting tendency and resistant to downy mildew, caused by *Peronospora farinose* (FR.:FR.) FR. As a line, it has an intermediate sized canopy that is lighter green than most germplasm developed at Salinas and tends to become yellowish late in the season.

CZ25-9 is approximately 50% high sugar Polish germplasm and 50% population 912. Population 912 was developed at Salinas and segregates for self-fertility, genetic male sterility, and resistance to rhizomania. Population 912 is similar to C918 (PI 578079)(USDA, 1993) released in 1993. The Polish component was from nine diploid, multigerm, S^sS^s, type-ZZ lines obtained from Dr.H.Szreder, Hodowla Buraka Cukrowego, Poland, in 1988. A composite of the Polish accessions was crossed to genetic male-sterile plants from population 912. Plants from the F_1 population were selected for resistance to rhizomania and increased in bulk. Depending upon the segregation for self-sterility, the F_2 would have been derived by either selling or sib mating. Thus, recombination was incomplete. Plants from within the F_2 line were selected for resistance to rhizomania and plant type and bulk increased. Again, F_3 individuals could have resulted from selfing or sibbing, depending upon segregation for self-sterility and genetic male sterility, and could potentially have been S_os, S_1s, or S_2s. The F_3 was designated Z325 and was one of the components of the population released as CZ25 (PI 599343)(USDA, 1997). Randomly selected pollen fertile plants from Z325 were selfed under paper bags in the greenhouse to produce selfed progeny families. Individual plants would have descended from as few as two plants or through recombination, from as many as 16 initial parental plants. Based upon per se performance for resistance to rhizomania and sucrose concentration, line Z625-9 was selected, increased to produce line Z825-9, and topcrossed to a monogerm tester. On the basis of its hybrid performance for sugar yield and sucrose concentration, line Z825-9 was increased to

produce line Z025-9. Line Z025-9 is being released as CZ25-9. Distributed seed was produced on the genetic male-sterile segregants within line Z825-9.

CZ25-9 should be evaluated as a potential pollinator to produce high sugar hybrids where resistance to rhizomania is needed, but high resistance to other diseases is not. It could be useful also as a high sugar, rhizomania resistant source line for further improvement of sugarbeet. CZ25-9 has a substantially different genetic background than lines traditionally released from the Salinas program (Lewellen, 1992). U.S. Plant Variety Protection will not be sought for CZ25-9.

Breeder seed is maintained by the USDA-ARS, and will be provided to sugarbeet researchers in quantities adequate for reproduction, upon request to the author (rtlewellen@hotmail.com).

LEWELLEN, R.T. 2002. Registration of Monogerm Rhizomania Resistant Sugarbeet Parental Lines C833-5 and C833-5CMS. Crop Sci. 42:321-322.

Sugarbeet (*Beta vulgaris* L.) parental lines C833-5 (Reg.no PL-38, PI 615522) and C833-5CMS (Reg.no. PL-39, PI 615523) were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. These lines were released in 2001.

C833-5 is a narrowly based, self-fertile (S^f), red hypocotyl(RR), monogerm(*mm*), O-type that segregates for genetic male sterility(*aa*). It has a high frequency of the *Rz* allele for resistance to rhizomania, caused by *Beet necrotic yellow vein virus*. C833-5 is moderately resistant to bolting and sugarbeet *Erwinia*. It has intermediate resistance to *Beet curly top virus*, powdery mildew, caused by *Erysiphe polygoni* DC, and downy mildew, caused by *Peronospora farinose* (Fr.:Fr.)Fr. Relative to current commercial hybrids, hybrids with C833-5 perform best under *Beet yellows virus* infected conditions. C833-5 confers moderately high sucrose concentration and sugar yield to its experimental hybrids. As a line, it has a small, compact, dark green canopy. The reactions of C833-5 to *Cercospora beticola* Sacc., *Rhizoctonia solani* Kühn, and *Aphanomyces cochliodies* Drechs, are unknown.

C833-5 was extracted from the initial composite cross used to develop population 833, Population 833 was produced by crossing rhizomania resistant, monoger, genetic male-sterile plans from population 867 [Population 867 is a rhizomania resistant version of population 767; population 767 was developed from population C310(C6)(PI 590873) x C546(PI590649) (Doney,1995)] with composite of monoger, O-type, nonbolting, curly top resistant inbred lines. These lines included C562(PI590847), C546(PI590649),C718(PI590849),C762-17(PI560130), C790-15(PI564758), C790-68(PI590790). C766-62(PI560133),C767-46(PI560132), C796-43 (PI560131)(Doney,1995). From the initial F_1 rhizomania resistant, monogerm plants were selected and selfed to create selfed progeny lines. Each S_1 family was rogued to genetic male-sterile plants and topcrossed. These topcross hybrids were evaluated in replicated yield and disease evaluation trials. On the basis of these trials, S_1 5833-5 were identified. Plants from 5833-5 were selfed and simultaneously crossed to an annual, male-sterile, O-type tester. Individual S_2 lines were evaluated for resistance to rhizomania and putative homozygous *RzRz* lines identified. The S_2 families that appeared to be O-type and *RzRz* were composited and

increased through the segregating genetic male-sterile plants to produce line 0833-5. Line 0833-5 has been released as C833-5. In addition, a new-cytoplasmic-male-sterile equivalent, C833-5CMS was released. C833-5CMS resulted from the second backcross of C833-5 to the F_1 hybrid C790-15CMS x 5833-5. C833-5CMS has been evaluated as breeding lines 9833-5HO and 0833-5HO.

C833-5 traces from one fertile (Aa). S_o plant from the composite cross to produce population 833. It is unknown what monogerm, inbred line contributed the male gamete to produce this plant. Because C833-5 is homozygous for red hypocotyl color, all potential sources can probably be eliminated except C790-15 (Lewellen, 1994) or 790-68 (Lewellen and Skoyen, 1987).

Although neither C833-5 nor C833-5CMS is yet used in commercial hybrids, their performance is experimental hybrids and combined disease resistance make them potential candidates for use as a parental line. C833-5 may be useful as a source for continued line improvement. U.S. Plant Variety Protection will not be requested for C833-5 or C833-5CMS.

Breeder seed is maintained by the USDA-ARS and will be provided to sugarbeet researchers in quantities adequate for reproduction, upon request to the author (rtlewellen@hotmail.com).

LEWELLEN, R.T. 2002. Registration of Sugarbeet Germplasm CR09-1 with Dual Resistance to *Cercospora* and Rhizomania. Crop Sci. 42(2): 672-673.

Sugarbeet (*Beta vulgaris* L.) germplasm line CR09-1 (Reg. no. GP-220, PI 615521) was developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and California Beet Growers Association. This line was released in 2001. CR09-1 is a narrowly based, multigerm (*MM*), self-fertile (S^f), red hypocotyl (RR), diploid line that segregates for genetic male sterility. It segregates for the *Rz* allele for resistance to rhizomania (caused by *Beet necrotic yellow vein virus*). In addition, the resistance to rhizomania found in line C79-6 (Pi 593665) may occur (Lewellen, 1997), CR09-1 has fair resistance to Cercospora leaf spot (caused by *Cercospora beticola*) based upon nursery tests at Salinas, CA, Fort Collins, CO, and Shakopee, MN. CR09-1 has moderate resistance to sugarbeet *Erwinia* and downy mildew [caused by *Peronospora farinose* (Fr.:Fr.)Fr.]. It has an intermediate reaction to bolting, *Beet curly top virus*, powdery mildew (caused by *Erysiphe polygoni* DC), and virus yellows complex caused by Beet yellows and *Beet western yellows viruses*. In bolted, seed production phase, CR09-1 has a tendency for plant loss due to a crown rot of unknown cause. This crown rot has not been observed in the vegetative rosette stage or in its experimental hybrids. As a line, CR09-1 has a small canopy with erect leaves and only fair vigor and seed yield potential. Its experimental hybrids have large, upright canopies.

CR09-1 was isolated from a population similar to CR09 (PI 593692) (USDA,1996) released in 1996. An Italian accession with resistance to Cercospora leaf spot and rhizomania called R05 was obtained from E.Biancardi at Rovigo, Italy, in 1987. This line was crossed to Salinas population 747 that has moderate to high resistance to curly top, *Erwinia*, virus yellows, and bolting. After one cycle of recombination, stecklings from this F_2 were crossed to population

918 (PI 578079) (Usda,199). Population 918 is similar to 747 but has resistance to rhizomania. After one cycle of full-sib family selection for combined resistance to rhizomania and Cercospora leaf spot, the synthetic R409 was produced. Individual plants from R409 were selfed to produce S_1 progeny. These S_1 progeny families were evaluated for dual resistance to rhizomania and Cercospora leaf spot at Salinas. An increase of the family with the best combination of disease resistance and agronomic traits was designated R709-1. One additional cycle of mass selection for resistance to rhizomania was made within this line to produce line CR909-1. CR909-1 was increased through segregating genetic-male-sterile plants to produce line CR009-1 and released as CR09-1.

At the same time that the bulk increases of this line were being made, it was crossed to a monogerm, cytoplamic-male-sterile tester. Productions of this testcross hybrid were evaluated in disease and yield trials at Salinas and Brawley, CA. These trials showed that CR09-1 has good combining ability for sugar yield with intermediate sucrose concentration.

CR09-1 may be useful as a germplasm source for further improvements in resistance to Cercospora leaf spot combined with other diseases. It needs to be evaluated as a potential pollinator or commercial hybrids where resistance to both rhizomania and *Cercospora* are needed. Because the source of resistance to *Cercospora* is from a recent Italian accession, it may be of interest to determine if this resistance is the same as in the traditional USDA *Cercospora* resistant base or if CR09-1 may contribute new and complementary genes to *Cercospora* resistant breeding programs. U.S. Plant Variety Protection will not be sought for CR09-1.

Breeder seed is maintained by the USDA-ARS and will be provided to sugarbeet researchers in quantities adequate for reproduction, upon request to the author (rtlewellen@hotmail.com).

LEWELLEN, R.T. and J.K. SCHRANDT. 2001. Inheritance of powdery mildew resistance in sugar beet derived from *Beta vulgaris* subsp. *maritima*. Plant Disease. 85:627-631.

Powdery mildew of sugar beet (*Beta vulgaris*), caused by *Erysiphe polygoni*, was introduced into North America in 1974. Since then, chemical control has been needed. Moderate resistance of a slow-mildewing type is known and has been used commercially. High resistance was identified recently in *B.vulgaris* subsp. *maritima* accessions WB97 and WV242 and has been backcrossed into sugar beet breeding lines. These enhanced lines were used as sources of powdery mildew resistance to determine the inheritance of resistance. Analyses of segregating test-cross families showed that resistance from both sources is inherited as a single, dominant, major gene. The gene symbol *Pm* is proposed for the resistant allele. The allelism of the resistance from the two wild beet sources was not determined. *Pm* conditions a high level of resistance, but disease developed on matured leaves late in the season. This late development of mildew on lines and the slow-mildewing trait in susceptible, recurrent lines tended to obfuscate discrete disease ratings.

LIU, H.-Y., G.C. WISLER, W.M. WINTERMANTEL and J.L. SEARS. 2001. Differentiation of poleroviruses in sugarbeet. J. Sugar Beet Research. 38:84.

Beet poleroviruses including Beet western yellows virus (BWYV), Beet chlorosis virus (BChV), and Beet mild yellowing virus (BMYV) induce yellowing symptoms and cause severe losses in sugarbeet, as well as other economically important crops grown throughout the world. BMYV has, to date, not been found in the USA. Although the symptoms of BWYV resemble those induced by BChV, BWYV isolates from sugarbeet have a wide host range and are readily distinguished by systemic infection of shepherd's purse (Capsella bursa-pastoris) and fail to infect Chenopodium capitatum. BChV has a narrow host range and produces interveinal reddening on C.capitatum but does not infect shepherd's purse. Serologically, beet poleroviruses can not be distinguished from one another by using either polyclonal antisera or mose monoclonal antibodies. Viral RNA was extracted from BChV virions and DNA fragments corresponding to different portions of the viral RNA were produced by reverse transcriptions followed by the polymerase chain reaction (RT-PCR). Purified RT-PCR products were cloned and sequenced. Analysis of the preliminary sequencing data revealed that BChV is composed of 6 major open reading frames (ORFs), all on the plus strand. ORF-3 which encodes the viral coat protein, displayed a strong similarity to BMYV (92%) and the European BWYV FL1 isolate (BWYV FL1)(94%). In contrast, the 5'-penultimate ORF-0 has only 5% similarity to BMYV and BWYV-FL1. Development of specific prime pairs or probes derived from ORF-O that can be used for discrimination of different poleroviruses is in progress.

TURINI, T.A., J.S. GERIK, and R.LEWELLEN. 2002. Comparison of fungicides for control of powdery mildew on Sugar Beet, 2001. Fungicide & Nematicide Tests. APS Press. In press.

The study was conducted at Imperial Valley Research Center in Brawley, CA on Holtville silty clay. Beds were spaced 30 in. center to center. On 10 October 2000, 'Rival' cv. Sugar beet seed was sown and irrigated. The experimental design was a Latin Square with six replications. Each plot consisted of 50 feet of 4 rows. Treated areas were separated by one untreated planted row. On 14, 29 March and 19 April, materials were applied in 30 gallons of water per acre with the CO_2 pressurized backpack sprayer at 30 psi. Maximum and minimum temperature ranges (°F) were as follows: Dec 68-80, 30-45; Jan 57-78, 30-40; Feb 58-84, 30-50; Mar 67-91, 37-58; April 72-98, 40-57; May 81-106, 49-70. Rainfall quantities (in.) are as follows: Dec 0.00, Jan 0.12, Feb 0.55, Mar 0.56, Apr 0.00, May 0.00. On 19 April and 16 May, powdery mildew severity on upper and lower leaf surfaces on each of 10 randomly selected leaves per plot were rated based on percentage of leaf surface covered with powdery mildew. The rating scale was as follows: 0=0%, 1=20%, 3=60%, 4=80% and 5=100%.

Powdery mildew was first detected on 9 March and severity increased to levels that allowed us to see treatment differences by 19 April. Plants treated with Eminent, Procure, and Microthiol Special had lowest disease severity. In addition, BAS 500 + Latron B-1956 provided similar control to the best performing materials, but disease was more severe on the upper leaf surface. All materials consistently provided significant levels of control compared to the non-treated control on lower leaf surfaces and only Quadris did not reduce disease severity on the upper leaf surface.

WEILAND, J.J. and M.H. YU. 2001. Molecular genetic tagging of resistance in sugarbeet to root knot nematode (*Meloidogyne* species). J. Sugar Beet Research. 38:103.

Incorporation into sugarbeet (*Beta vulgaris* L.) of resistance to root knot nematode has been an ongoing project at the USDA-ARS laboratory in Salinas, CA. Resistance discovered in *Beta maritima* appears to be simply inherited and is effective against multiple species and races of nematode belonging to the genus *Meloidogyne.* Sugarbeet population accession 1568 segregating for a resistance to root knot nematode was used in an effort to develop molecular genetic markers tagging this resistance. Preparations of DNA were made from leaves of plants that exhibited susceptibility or resistance to nematode after inoculation in a greenhouse. Pooled DNA of segregants was used to identify markers associated with the resistance using the random amplified polymorphic DNA technique. At least 5 DNA markers were obtained that co-segregated with nematode resistance. One marker was coupled in repulsion to the resistnace. The use of this marker in the incorporation of nematode resistance into elite sugarbeet breeding germplasm is discussed.

WINTERMANTEL, W.M. and A.A. CORTEZ. 2001. Complementation for transmission by non-vector whiteflies among tomato-infecting criniviruses. Phytopathology 91 (6): S96.

Tomato chlorosis crinivirus (ToCV) and *Tomato infectious chlorosis crinivirus* (TICV) appear to have largely distinct geographical distributions, but have been found together in field-grown tomato. TICV is transmitted only by *Trialeurodes vaporariorum*, while ToCV is transmitted by*T. vaporariorum*,, *T. abutilonea* and two *Bemisia* species. Both viruses have similar genome size and organization, suggesting the potential exists for transmission by non-vector whiteflies from mixed infections. We established *Physalis wrightii* source plants, containing either TICV alone, ToCV alone, or both viruses together, confirmed by northern blot to virus specific probes. *T. vaporariorum* and *T. abutilonea* were allowed to feed separately on all virus sources, as well as virus-free plants for 24 hours, then were transferred to young host plants. Symptomatic plants were tested by northerns as before, and transmission of TICV by *T. abutilonea* from mixed infection was confirmed in two of sixty plants. Although cross-transmission does not appear to occur frequently, this rate is substantial considering the high whitefly populations that can occur in the field.

WINTERMANTEL, W.M., J. SEARS and M.PARRISH. 2001. Synergism and Host Effects in Virus Yellows of Sugarbeet. J. Sugar Beet Research. 38:105.

"Virus yellows" refers to a viral disease complex that results in generalized leaf yellowing of sugarbeet. The complex includes *Beet yellows closterovirus* (BYV) and *Beet western yellows polerovirus* (BWYV) as single or mixed infections, with *Beet mosaic potyvirus* (BtMV) often associated as well. Sugarbeet varieties exhibiting differential levels of tolerance to the yellows complex were inoculated with every combination of one, two or all three viruses. Relative levels of virus were compared among single and mixed infections using dot blot hybridization. Virus titers in sugarbeet were not substantially affected by the presence of multiple viruses, but specific mixed infections severely affected growth of beet plants. Mild increases in stunting severity

were found in mixed infections of BYV and BWYV, but these increases were not significant. Mixed infections of BYV with BtMV, however, caused severe stunting in sugarbeet, compared to single infections of either virus or combinations of BYV with BWYV. Synergistic effects on stunting severity were more pronounced in susceptible beet varieties, but similar patterns were also observed in lines exhibiting tolerance to virus yellows. Virus concentration was also affected by mixed infections. Levels of BYV and BtMV were most affected by the presence of an additional virus, as compared to virus levels in single infections.

WINTERMANTEL, W.M., G.C. WISLER, R.T. LEWELLEN, H.-Y. LIU, and J. SEARS. 2001. Interactions between BNYVV and BSBMV affect virus titer and beet development. Phytopathology 91 (6): S150.

Beet necrotic yellow vein virus (BNYVV), which causes rhizomania disease of sugarbeet, produces striking hairy root symptoms and results in severely diminished sugar yield and root weight. *Beet soil-borne mosaic virus* (BSBMV) does not produce these severe symptoms, but also reduces yields. Both *Benyviruses* are transmitted by the soil-borne fungus, *Polymyxa betae.* The Rz gene, which is highly effective in controlling rhizomania symptoms, does not confer resistance to BSBMV. These viruses are frequently found together in western U.S. beet fields. We are attempting to determine how the presence of both viruses together affects beet yield, sugar content and virus concentration. To address these questions, sterile soils were inoculated with viruliferous beet roots containing *P. betae*, or *P. betae* carrying one and/or both viruses as single and mixed infections. Results demonstrated that concentrations of both viruses individually increased early, then began to decline. In addition, BSBMV levels were suppressed in mixed infections with BNYVV, and BNYVV levels appear to increase in the presence of BSBMV, suggesting synergism between these viruses.

WISLER, G.C., R.T. LEWELLEN, H.-Y. LIU, J.SEARS, and W.M. WINTERMANTEL. 2001. Interactions between BNYVV and BSBMV in rhizomania resistant and susceptible sugarbeet varieties and effects on beet development. J. Sugar Beet Research. 38:106.

Beet necrotic yellow vein virus (BNYVV), the cause of Rhizomania, produces striking root and sometimes foliar symptoms, and results in considerable sugar content and yield reductions. This virus was introduced from Europe and has since spread throughout many beet growing regions in the U.S. In contrast, *Beet soil-borne mosaic virus* (BSBMV) appears to have originated and evolved in the U.S. Although this virus does not produce the severe losses that result with BNYVV infection, it does appear to have some effect on yield. Recent studies have demonstrated that although these viruses are closely related, Rz gene-resistance to BNYVV does not confer resistance to BSBMV. Both viruses are transmitted by *Polymyxa betae* and are being found together in increasing numbers of beet fields in the western United States. As a result, we are not only attempting to ascertain the existence of resistance to BSBMV, but also to determine whether the presence of both viruses together substantially affects beet yield, sugar content and virus concentration. To determine the effect of single and mixed infections of BNYVV, BSBMV, as well as virus-free *P. betae* on susceptible and rhizomania resistant sugarbeet, sterile soils were inoculated with viruliferous beet roots containing *P. betae*, or *P. betae* and one or both

viruses. These soils were used in greenhouse tests to explore the effects of mixed infection. Results demonstrated that concentrations of both viruses increased for 3-4 weeks in all combinations, then virus levels begin to decline. In addition, BSBMV levels were suppressed in mixed infections with BNYVV, and BNYVV levels appear to increase substantially in the presence of BSBMV, suggesting a possible synergism between these viruses.

YU, M.H. 2001. Increase Sugarbeet Production Through Resistance Breeding. Asian Agriculture Congress Abstr. p137.

The sugarbeet (*Beta vulgaris* L.) serves as a reliable source of high quality sugar to sweeten foods for human consumption. Yet, the growth of sugarbeet crop confronts many challenges, including infection by nematode. Root-knot nematode (*Meloidogyne* spp.) is one of the pathogens of sugarbeet that reduces beet yields and is difficult to manage in the infested fields. With the dwindling availability of nematicide and soil fumigants, breeders are looking at resistant sugarbeet variety as an alternative to control root-knot nematode. Host-plant resistance to nematode has been discovered from rare strains of non-cultivated wild beets. Resistance is to multiple species of *Meloidogyne*. Currently, sugarbeet root-knot nematode resistance breeding is in progress and improved genotypes are being developed. In nematode infested plots, resistant sugarbeet showed little root gall symptoms and produced much higher yields than the susceptible plants. Breeding sugarbeet resistance to root-knot nematode, therefore, is desirable and will increase beet sugar production.

YU, M.H. 2002. Registration of M1-2 Beet Germplasm Resistant to Root-Knot Nematode. Crop Sci. 42:317-318.

Beet [*Beta vulgaris* ssp. *Maritima* (L.) Arcang] germplasm line M1-2 (Reg.no. GP-218,PI614899) was developed by the USDA-ARS in cooperation with the California Beet Growers Association, Ltd. And jointly released in July 2000. This germplasm line is resistant to root-knot nematode, *Meloidogyne* spp.

The initial seed of M1-2 was produced by interpollinating 40 root-knot nematode resistant plants selected from over 250 second generation Mi-1 (PI593237) progeny (Yu,1997). It is highly resistant, if not immune to root-knot nematode. M1-2 is a multigerm, partially self-compatible germplasm line with a high percentage (85% or more) of plants exhibiting annual bolting habit and pigmentation. The roots are fanged or sprangled (to a lesser degree than Mi-1) with a medium fiber texture. M1-2 is resistant to several species of root-knot nematode, including *M. incognita* (Kofoid and White) Chitwood, *M.javanica* (Treub.) Chitwood, *M.arcnaria* (Neal) Chitwood, *M.hapla* Chitwood, *M.chitwoodi* Golden et al., and *M.fallax* Karssen (Yu et al., 1999). Both M1-2 and M6-1 (PI613165) (Yu,2001) are resistant to root-knot nematode, but their reactions to phosphoglucomutase (PGM) isozyme stain on starch gels are different. All F_1 progeny of M1-2 produce a parental PGM banding pattern that is associated with root-knot nematode resistance (Yu et al., 2001). However, such a reaction has not been observed with M6-1 and its progeny. This suggests that resistance to *Meloidogyne* spp. In M1-2 and M6-1 is of different origin or conducted by different genes or alleles.

Breeder seed will be maintained by the USDA-ARS and provided to sugarbeet breeders and researchers in small quantities upon written request. Recipients of seed are requested to make appropriate recognition of the source of M1-2 contributes to the development of a new population, parental line, cultivar, or hybrid. U.S. Plant Variety Protection for M1-2 will not be applied for.

YU, M.H. 2001. Registration of M6-1 Root-Knot Nematode Resistant Sugarbeet Germplasm. Crop Sci. 41:278-279.

M6-1 is a multigerm, self-compatible, green-hypocotyl, and largely biennial sugarbeet line. M6-1 is an increase of pooled homozygous root-knot nematode resistant S_2 progeny plants selected from a cross between a diploid, self-fertile, resistant plant, 1610, and a diploid, self-incompatible, biennial sugarbeet line, C39R (PI560336). Plant 1610 was a descendant of hybridization between root-knot nematode resistant beet germplasm M66 [*B.vulgaris* subsp. *maritima* (L) Arcang; PI586688] and an annual, self-compatible, O-type, multigerm sugarbeet line, 4500 (SLC 003). Some progeny of 1610 showed slight inbreeding depression, and a low frequency of dwarf mutants was observed occasionally. The M6-1 germplasm has a high level (if not homozygous) resistance to multiple species of *Meloidogyne.* In comparison, progeny of M66 segregated for resistance to root-knot nematode.

YU, M.H. 2001. Resistance to *Meloidogyne* spp. and improvement of sugarbeet cultivars. J. Sugar Beet Research. 38:109.

The production of sugarbeet (*Beta vulgaris* L.) crops encounters numerous challenges, including attach from root-knot nematode in infested areas. *Meloidogyne* spp. Is a destructive pest of sugarbeet that reduces yield and quality of the harvest. The available wild beet source of host-plant resistance is effective against all four economically important *Meloidogyne* species. Transferal of resistance from wild beets to cultivated sugarbeet was achieved by means of hybrid crosses and screening procedures. Performances of nematode resistant sugarbeet experimental lines were observed in field planting. In non-infested soils several resistant populations produced sizable taproots, even though root conformations were less uniform and root weights were lower than the control. Under root-knot nematode infested conditions, yields of susceptible control plants were noticeably lower than that of the resistant counterparts. Intensive genotype-environment interactions expressed more readily to susceptible sugarbeet when secondary invasion and/or high temperature elements were involved. Development of sugarbeet with resistance to *Meloidogyne* spp., therefore, is the most desirable and environmentally safe means to solve the production problems due to root-knot nematode.

YU, M.H., L.M. PAKISH and H.ZHOU. 2001. An Isozyme Marker for Resistance to Root-Knot Nematode in Sugarbeet. Crop Sci. 41:1051-1053.

Root-knot nematode (*Meloidogyne* spp.) is a destructive pest of sugarbeet (*Beta vulgaris* L.) that reduces production in infested areas and is difficult to manage. Identification of nematode-

resistant plants is a time-consuming process that is subject to genotype-environment interaction. Development of resistant cultivars/hybrids is the most effective control. This study was conducted to establish a rapid and effective screening technique to detect a large number of sugarbeet genotypes with resistance to *Meloidogyne* spp. A nematode-resistant sugarbeet germplasm line, Mi-1 *Beta*, was previously developed using J2 inoculation and screening procedures. Leaf and cotyledon extractions were used in diagnosis. Phosphoglucomutase (PGM) was found to be potentially useful isozyme marker of resistance in Mi-1 *Beta* and derived lines in starch gel electrophoresis. Seven banding patterns (four resistant and three susceptible) were produced. All susceptible plants shared the banding pattern of the resistant strains, except for a single PGM band. If demonstrated to be tightly linked to nematode resistance, this novel PGM isozyme marker will accelerate breeding sugarbeet with resistance to root-knot nematode.

DEVELOPMENT OF SUGARBEET BREEDING LINES AND GERMPLASM

R.T. LEWELLEN

C67/2, C69/2, C78/3, & C80/2 - C67/2 (PI628750), C69/2 (PIPI628731), C78/3 (628752) and C80/2 (PI628753) are self-sterile (S^s S^s), multigerm (*MM*), sugarbeet (*Beta vulgaris L.*) breeding lines that segregate for resistance to rhizomania. Resistance to rhizomania is conditioned by *Rz*. These lines have predominantly red (*R_*) hypocotyls. Earlier versions of these lines have been released previously. These breeding lines represent long term and continuing efforts to improve sugarbeet and combine resistance to disease. This set of lines encompasses a broad cross section of the "Salinas" multigerm germplasm base. The development of these breeding lines spans 20 to 60 years and includes germplasm developments for productivity combined with resistance to curly top, bolting, virus yellows, *Erwinia*, powdery mildew, rhizomania, downy mildew, and rust. Sugar yield tends to be primarily of the N-type but full-sib and other types of progeny tests have shown wide genetic variability for components of productivity.

C67/2 was released previously as C67 (PI599340) in 1998. Since that release, this breeding line has under gone two additional cycles of recurrent phenotypic selection. In both cycles, emphasis was placed on selecting mother roots for sucrose concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. Plants that bolted before harvest were eliminated. C67/2 is estimated to have about 10% of its germplasm from *B.vulgaris* subsp. *maritima* (*Bvm*). The *Bvm* germplasm was derived from R322Y3%, a component of C51 (PI593694), that had been selected for combined resistance to rhizomania, virus yellows, and agronomic traits. The sugarbeet germplasm was largely from C37 (PI590715), C78 (PI593671), C80 (PI593672), and C82 (PI593675). Resistance to rhizomania is conditioned by both *Rz* and factor(s) from C51 (*Bvm*) that gives a high level of resistance under high temperature conditions. During its development C67/2 has been tested as Y967 and Y167.

C69/2 was released previously as C69 (PI599341) in 1998. Since then, this breeding line has undergone two additional cycles of recurrent phenotypic selection. In both cycles, emphasis was placed on selecting mother roots for sucrose concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. C69/2 is predominantly the germplasm of C31/6 (PI590799) with smaller amounts from C37, C46/2 (PI590800), C39 (PI583373), C64, and other sources. C69/2 is moderately resistant to virus yellows, bolting, powdery mildew, and *Erwinia*. It is moderately susceptible to curly top. During its development, C69/2 has been tested as breeding line numbers Y969 and Y169.

C78/3 was previously released as C78/2 (PI593695) in 1996 and C78 (PI593671) in 1994. Since being released as C78/2, C78/3 has undergone three additional cycles of recurrent phenotypic selection. In each cycle, emphasis was placed on selecting mother roots for sucrose

concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. C78/3 is predominantly the germplasm from curly top resistant breeding line C46/2 (PI590800). C78/3 is moderately resistant to virus yellows, bolting, powdery mildew, Erwinia, and curly top. During its development, C78/3 has been tested as breeding line numbers R578, R578/2, R578%, R778, R778%, R978 and R178. Although handled as if completely self-sterile ($S^s S^s$), recent use of C78/3 progenitors as a recurrent parent in backcrossing programs has shown that some plants express various degrees of self-fertility.

C80/2 was previously released as C80 (PI593672), C80NB (PI593673), and C80-45 (PI593674) in 1994. These sublines were recombined to produce C80/2. C80/2 has undergone four additional cycles of recurrent phenotypic selection. The first of these four cycles was for resistance to rhizomania in 4-month old plants within C80, C80NB, and C80-45. Selected plants from these lines were recombined into one population. In each of the next three cycles, emphasis was placed on selecting mother roots for sucrose concentration, size, and conformation from field plants grown under rhizomania conditions, inoculated with virus yellows and sugarbeet *Erwinia*, and naturally infected with powdery mildew. C80/2 was developed from a broad base of breeding lines in the virus yellows and multiple disease resistance program at Salinas. During its development, C80/2 has been tested as breeding line numbers R580, R580-45, R580NB, R780/2, R780-45, R980, and R180.

Lines C67/2, C69/2, C78/3, and C80/2 may be useful for continued line improvement and as sources of multiple disease resistant germplasm. These four lines represent a broad germplasm base and encompass much of the germplasm developed in the long term breeding program at Salinas. They account for much of the germplasm from the virus yellows (BYV/BWYV) breeding program that has been ongoing since 1955. Based upon previous successes and evidence from progeny family evaluations (both S_1 and full sib), these lines may continued to be useful as sources from which to extract parental lines.

Seed of C67/2, C69/2, C78/3, and C80/2 will be maintained at the USDA,ARS, U.S. Agricultural Research Station, Salinas, California, and will be provided upon written request to sugarbeet breeders in sufficient quantities for reproduction. Genetic material of these releases has been deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new parental lines and cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new breeding line or cultivar. The National Germplasm System and additional information on prior releases and PI numbers can be found at: www.ars-grin.gov. Requests for seed should be made to Dr. R.T. Lewellen, USDA,ARS, U.S. Agricultural Research Station, 1636 East Alisal Street, Salinas, CA 93905 (T 831 755-2833, F 831 755-2814, lewellen@pwa.ars.usda.gov or rtlewellen@hotmail.com).

C869 & C869CMS - C869 (PI628754) is a monogerm (*mm*), O-type, self-fertile (S^f), genetic-male-sterile (*A_:aa*) facilitated, random mated population. It segregates for resistance to rhizomania conditioned by the *Rz* allele. It has mostly red (*R*) hypocotyls. It is moderately resistant to curly top and has genetic variability for high levels of resistance. C869 has wide

variability for reaction to bolting, *Erwinia*, and powdery mildew. C869 is an N-type for sucrose concentration with average sugar yield combining ability.

C869CMS (PI628755) is the cytoplasmic male sterile counterpart of C869. It will be useful to quickly develop CMS equivalents of any lines extracted or developed from C869. It may also be useful as a monogerm, CMS tester to evaluate multigerm lines for general combining ability.

C869 is a moderately based population with good monogerm and O-type traits. It has good plant vigor and seed yield potential. The initial development of C869 up to 1995 was complex, circuitous, and involved developing and recombining subpopulations and selected progeny lines from various cycles of development and selection. Collectively, C869 comprises about 44% of its germplasm from C790 (PI515964) through C890 (PI593700); 12.5% from C310 (C6) (PI590873); 12.5% from curly top and Erwinia resistant monogerm inbred C546 (PI590649); and about 31% from the original source of *Rz*. C790 was a broad based monogerm, self-fertile population that had undergone five cycles of S_1 progeny recurrent selection for sugar yield and was the source of monogerm inbreds such as C790-15 (PI564758). C310 was a monogerm, self-fertile population that had proven valuable as a source of lettuce infectious yellows virus resistant parental lines, e.g., C301 (PI590717). Since 1995 when population 867 [(C310 x C546)aa x Rz source] and C890 were combined to form 5869, the progenitor of C869, four cycles of selection have been done. These included individual and combined selections for monogerm, rhizomania resistance, O-type, resistance to *Erwinia*, powdery mildew, bolting, and for higher sucrose content. From these cycles of selection, subpopulations 7869NB, 7869, and 8869 were formed.

Mother root selections from these were recombined in 1999 to produce 9869. In 2000, high quality, monogerm plants of 9869 were selfed to produce selfed progeny families. These families were indexed for O-type and separately evaluated for resistance to rhizomania. About 600 plants from 24 selfed families (i.e., 24 S_0 plants) that appeared to be O-type and have resistance to rhizomania were recombined through their genetic male sterile segregants to produce 1869. Seed of 1869 is being released as C869. In 1996, plants of 5869 were increased through their male sterile segregants to produce 6869. Population 6869 was not used directly to produce C869 but was made available for genetic research and tentatively called C869.

C869 should be useful as a source of resistance to rhizomania and other diseases in a monogerm, O-type background. Sufficient genetic variability should still occur to permit continued population improvement and as a source of potential parental lines. C869 may be useful also as a base population from which to develop additional populations and breeding lines.

Seed of C869 and C869CMS will be maintained at the USDA,ARS, U.S. Agricultural Research Station, Salinas, California, and will be provided upon written request to sugarbeet breeders in sufficient quantities for reproduction. Genetic material of these releases has been deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new parental lines and cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new breeding line or cultivar. The National Germplasm System and additional information on prior releases and PI numbers can be found at: www.ars-grin.gov. Requests for seed should be made

to Dr. R.T. Lewellen, USDA,ARS, U.S. Agricultural Research Station, 1636 East Alisal Street, Salinas, CA 93905 (T(831)755-2833, F(831)755-2814, lewellen@pwa.ars.usda.gov or **rtlewellen@hotmail.com**).

C927-4, C929-62, C930-19 & C930-35 - C927-4 (PI628756) is a narrowly based, self-fertile (S^f), multigerm (*MM*), sugarbeet (*Beta vulgaris* L.) line with high resistance to rhizomania. Resistance to rhizomania is conditioned by *Rz* and factor(s) from *B.vulgaris* subsp. *maritima* (*Bvm*). It segregates for hypocotyls color (*R_:rr*) and genetic male sterility (*A_:aa*). C927-4 produces hybrids with intermediate sucrose content and high sugar yield. These hybrids perform relatively best when grown under rhizomania conditions.

C927-4 was derived from a population cross between population C918(PI578079) and population 921. Population C918 is a multigerm, self-fertile, genetic-male-sterile facilated, random-mated population. Population 921 was developed from crosses between population C918 and lines R322Y3 and R322R4. Lines R322Y3 and R322R4 are similar to C51 (PI593694) (improved C50, PI538251) that was developed from composite crosses between sugarbeet and *Bvm*. Theoretically, about 12% of C927-4 would be from *Bvm*. Population C918 is a source for the *Rz* allele for resistance to rhizomania. From C51, additional factors for resistance occur that condition improved resistance and survivability of plants under the combined effects of severe rhizomania and high temperature stress. C927-4 possesses this type of resistance to rhizomania. From the F_1 population hybrid between genetic-male-sterile plants from C918 and pollen from 921, individual S_o plants were selected for sucrose concentration under virus yellows (VY) inoculated (BYV/BWYV) conditions and selfed under bags to produce S_1 progeny families. These S_1 progenies were evaluated for resistance to rhizomania at Salinas and Brawley, CA, for performance under VY inoculated conditions at Salinas and Davis, CA and for bolting tendency at Salinas. On the basis of these tests, S_1 progenies were selected, increased in isolation, and testcrossed to a monogerm tester to produce experimental hybrids. Line 9927-4VY was selected for further evaluation based on the performance of its experimental hybrid. Line 9927-4VY was increased through its genetic-male-sterile segregants to produce line 1927-4 that is being released as C927-4.

C929-62 (PI628757) is a narrowly based, self-fertile (S^f), multigerm (*MM*) sugarbeet line with high sugar yield combining ability. It has red hypocotyls (*RR*) and segregates for genetic male sterility (*A_:aa*). In tests at Salinas and Brawley, it appeared to be resistant to powdery mildew, *Erwinia*, and bolting. It is moderately susceptible to curly top and segregates for resistance to rhizomania (*Rz*). It produces hybrids with intermediate sucrose content and high sugar yield. It is likely moderately resistant to virus yellows.

C929-62 was derived from a population cross between genetic-male-sterile plants from population C918 and C76-89-18 (PI593699). Line C76-89-18 was advanced from one full-sib progeny that is susceptible to rhizomania but has high sugar yield combining ability and resistance to virus yellows, *Erwinia*, and bolting. It was selected from C31/6 (PI590799) type germplasm. From the F_1 population hybrid, individual S_o plants were selected for sucrose content under VY inoculated conditions and were selfed under bags to produce S_1 progenies. These S_1 progenies were evaluated at Salinas and Davis for performance under virus yellows inoculated conditions and at Salinas for components of sugar yield, resistance to rhizomania, and

nonbolting tendency. On the basis of these tests, S_1 progenies were selected, increased, and testcrossed to a monogerm, CMS tester. Line 9929-62VY was selected for further evaluation based on the performance of its experimental hybrid. Line 9929-62VY was increased through its male-sterile segregants to produce line 929-62 that is being released as C929-62.

C930-19 (PI628758) is a narrowly based, self-fertile (S^f), multigerm (*MM*) sugarbeet line with high resistance to bolting. It segregates for hypocotyl color (*R_:rr*) and genetic male sterility (*A_:aa*). It appears to be resistant to *Erwinia* and moderately resistant to curly top and powdery mildew. It segregates for resistance to rhizomania (*Rz*). In tests at Salinas and Brawley, its hybrids had moderate to high sucrose content and sugar yield combining ability.

C930-19 was derived from a population cross made in 1995 between population C918 and breeding line C78(PI593671). C78 is a rhizomania resistant version of C46/2(PI590800). C46/2 has moderate curly top resistance and has been an important source of pollinators used commercially in California. From the F_1 population hybrid, individual S_o plants were selected for resistance to rhizomania and were selfed to produce S_1 progenies. These S_1 progenies were evaluated at Salinas for components of sugar yield and for resistance to bolting, rhizomania, powdery mildew, and virus yellows. On the basis of these tests, S_1 progenies were selected, increased, and testcrossed to a monogerm, CMS tester. Line 8930-19 was chosen from among this group for further evaluation based on the performance of its experimental hybrid. Over wintered stecklings from Oregon of 8930-19 were transplanted into a field isolation plot at Salinas. In the absence of an artificially extended photoperiod, stecklings of 8930-19 were very slow to bolt and some plants did not flower. During seed harvest, these non-flowering plants were saved, regrown in the greenhouse, and vernalized in a cold room for 140 days, then replanted into a greenhouse isolation chamber with a 24-hour photoperiod. Under these conditions, this nonbolting selection from line 8930-19 produced seed. This seed was harvested in bulk without regard to male sterile segregants and called 1930-19. Line 1930-19 is being released as C930-19.

C930-35(PI628759) is a narrowly based, self-fertile (S^f), multigerm (*MM*) sugarbeet line with high sucrose concentration. It has green hypocotyls (*rr*) and segregates for genetic male sterility (*A_:aa*). In tests at Salinas and Brawley, it appeared to be moderately resistant to curly top, *Erwinia*, powdery mildew, and bolting. It segregates for resistance to rhizomania (*Rz*).

C930-35 was derived from a population cross made in 1996 between genetic-male-sterile plants from one component of population CZ25 (PI599343) and breeding line C78. This component of CZ25 was a multigerm, self-fertile, genetic-male-sterile facilitated, random-mated population. It was developed from crosses between breeding sources similar to C918 and high sucrose accessions from Poland. About 25% of the germplasm of C930-35 would be Polish. The Polish germplasm was from 2n = 2x = 18 chromosome, multigerm, self-incompatible (S^sS^s), type-ZZ lines accessed from Dr. A. Szreder, Hodowla Buraka Cukrowego, Poland, in 1988 for use in the Salinas breeding program. A composite of nine Polish accessions were crossed to genetic-male-sterile plants from a progenitor of population C918 to ultimately produce population CZ25. From the F_1 population hybrid between CZ25 and C78, individual S_o plants were selected for resistance to rhizomania and were selfed in bags to produce S_1 progenies. These S_1 progenies were evaluated at Salinas for components of sugar yield and resistance to bolting, rhizomania,

and powdery mildew. At both Salinas and Davis, they were evaluated for sugar yield under VY inoculated conditions. On the basis of these tests, S_1 progenies were selected, increased, and testcrossed to a monogerm, CMS tester. Line 9930-35 was selected for further evaluation based on the performance of its experimental hybrid. Line 9930-35 was increased through its male-sterile segregants to produce line 1930-35 that is being released as C930-35.

Lines C927-4, C929-62, C930-19, and C930-35 were identified and selected from a program to combine multiple disease resistance and factors for productivity. S_1 progeny evaluations followed by testcross hybrid evaluations were used. S_1 progeny evaluation is known to be a useful plant breeding method to identify and improve traits with additive genetic variance, e.g., most disease resistances and sucrose content. However, breeding lines with self-incompatibility (S^sS^s) do not easily lend themselves to this breeding procedure but comprise most of the advanced, highly productive sugarbeet germplasm. The S_1 progeny from which the above lines were selected was part of a program to determine if self-incompatible lines could be worked quickly into an S_1 testing program. To test to see if this could be achieved, self-incompatible lines were crossed onto genetic-male-sterile plants from self-fertile, genetic-male-sterile facilitated, random-mated populations that had been undergoing population improvement. These F_1 population or line hybrids were then used as the source of the S_o plants to produce S_1 progenies. Because seed of the F_1 hybrids can be easily produced in large quantities, the S_o plants can be selected after rigorous evaluation for one or more moderate to highly heritable raits. In this scheme, most of the S_o plants will be pollen fertile (*Aa*) and their S_1 progenies will segregate $3A\_:1aa$, giving ample opportunity and flexibility for selecting materials to be used in a continuing line or population improvement program. For three of the four lines above, only 6 years from 1996 to present were needed to go from making the initial crosses to early generation lines with potential for development into parental lines.

Lines C927-4, C929-62, C930-19, and C930-35 should be evaluated as sources from which to develop potential pollinators for high performing, disease and bolting resistant hybrids. All of these lines will segregate for resistance to rhizomania, so there will need to be a cycle of selection for homozygosity (*RzRz*). It also may be useful to recombine two or more of these lines and/or to cross them to other germplasm to generate new synthetics or lines with favorable combinations of traits for population improvement and parental line extraction.

Seed of C927-4, C929-62, C730-19, and C930-35 will be maintained at the USDA,ARS, U.S. Agricultural Research Station, Salinas, California, and will be provided upon written request to sugarbeet breeders in sufficient quantities for reproduction. Genetic material of these releases has been deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new parental lines and cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new breeding line or cultivar. The National Germplasm System and additional information on prior releases and PI numbers can be found at: www.ars-grin.gov. Requests for seed should be made to Dr. R.T. Lewellen, USDA,ARS, U.S. Agricultural Research Station, 1636 East Alisal Street, Salinas, CA 93905 (T 831 755-2833, F 831 755-2814, Lewellen@pwa.ars.usda.gov or rtlewellen@hotmail.com).

POPULATION IMPROVEMENT IN SUGARBEET - This summary is extracted from a presentation made at the 31st General Meeting of the ASSBT, Vancouver, Canada, 2001. (See Abstracts of Papers in this report: Lewellen, R.T., 2001. Population improvement within multigerm, self-fertile random-mated breeding lines of sugarbeet. J. Sugar Beet Research. 38:84). Population improvement is the breeding procedure to add or increase breeding value to a line or population that is to be used as a source for extracting parental lines. In other words, it is a process to increase desirable gene frequency and increase the odds of extracting useful parental lines. It may be for a single, specific trait, e.g., rhizomania, sugar concentration, Cercospora leaf spot resistance, or combinations of traits. It is what breeders like myself do when we go beyond the earliest stages of pre-breeding but stop short of producing finished parental lines and commercial hybrids.

This summary will be a brief discussion on the development of multigerm, self-fertile, genetic male-sterile facilitated, random-mated populations for use in population improvement. Although any kind of progeny family and breeding procedure could be used, the use of S_1 or selfed progeny families for progeny evaluation will be emphasized. According to quantitative genetic models and theory, the additive genetic variance available for selection among selfed progenies or families is greater than that among full-sib, half-sib, or testcross families. Selection among S_1 families should be particularly useful for characters having low heritabilities because a larger portion of the additive genetic variance contributes to genetic advance than with other forms of intrapopulation selection.

The components of population improvement in my sugarbeet research program are shown in the tables below. These parts accommodate improvements for disease and pest resistance, improvements or changes in genetic structure, components of yield, and the introduction of new genetic variability. The introduction of new variability can range from elite high sugar sources to genes and traits from wild species, such as *Beta vulgaris* subsp. *maritima*.

POPULATION IMPROVEMENT IN SUGARBEET

1. Individual & Combined Disease Resistance
   Rhizomania, curly top, virus yellows, bolting, root rots, powdery mildew,....

2. Structure
   Multigerm vs. monogerm, O-type, CMS, Self-fertile vs. self-sterile, genetic ms,....

3. Adaptation (genotype x environment)

4. Productivity (combining ability)
   Root yield, % sucrose, purity

5. New Genetic Variability

Population improvement involves population breeding methods. Traditionally most of the useful genetic variability in sugarbeet is in self-sterile (S^sS^s), open-pollinated sources and germplasm. Except for producing S_1 or other selfed progeny lines, these open-pollinated sources can be worked into almost any breeding system. To overcome the problem of self-sterility, self-fertility (S^f) can be inserted to accommodate selfing and the production of inbred lines. However, the breeder then has a problem with obtaining controlled outcrossing and recombination. To overcome this problem, yet to be able to use the S^f factor, genetic male sterility (*a*a) was put into the population structure so that selfing, outcrossing and recombination could be controlled. The populations with combined self-fertility and genetic male sterility have been termed "self-fertile, genetic male-sterile facilitated, random-mated populations." These populations permit the use of all breeding methods.

POPULATION BREEDING METHODS IN SUGARBEET

	(OP)SELF STERILE	(S^f)SELF FERTILE	S^f, A:aa RANDOM-MATED
Mass selection	yes	no	yes
Inbreeding e.g. bulk,SSD,...	no	yes	yes
Intrapopulation Improvement (Recurrent Selection)			
Half-sib progeny	yes	no	yes
Full-sib progeny	yes	no	yes
S_1,S_2 progeny	no	no	yes
Interpopulation Improvement			
Reciprocal R.Sel.	no	no	yes

S^f,A:aa = self-fertile, genetic ms facilitated, random-mated population

Over the past 70-80 years, the germplasm base at Salinas (USDA programs at Salt Lake, UT, Riverside, CA, Salinas, CA) has been defined in terms of resistance to curly top virus. Then, defined in terms of the virus yellows resistance breeding program and more recently, by resistance or conversion to resistance to rhizomania. Lines such as C37 and C46 and their rhizomania resistant derivatives C79 and C78, respectively, are directly descended from the original curly top resistant germplasm sources. C01 and C31 were combinations of curly top resistant x susceptible sources. More recently, genetic variability from *B.v. maritima* has been introgressed into this base.

SOURCES OF RESISTANCE TO VIRUS YELLOWS

C37,C46 (curly top resistant)
R&G OT-> US22/3-> US75-> C13-> C17-> C37-> C79
R&G P -> US15 x US22/3-> C64 x C17-> C46-> C78

C03 (curly top susceptible)
IRS (Reitberg) -> Y34-> Y03-> C03

C01,C31 (ctr x cts)
CTR (Salinas) }
UK (Rose,Hull) } ->Y01-> C01-> C31-> C76-> C82
IRS (Reitberg) }

C51 (*Beta vulgaris ssp. maritima*)
Bvm x SB -> R22-> R22Y-> C51 x C46-> C67

It is largely from this CTR-VYR-*Rz* base that the Salinas self-fertile, genetic ms facilitated, random-mated populations have been developed. Early and ongoing developments have been gradually distilled into one important base population called 931 or popn-931.

MULTIGERM,SELF-FERTILE,GENETIC MALE-STERILE FACILITATED,RANDOM-MATED POPULATION-931

Trait	
Germplasm base	C37,C46, et al.
Seed	*MM*
Genetic male sterility	*A_:aa*
Compatibility	S^f
Rhizomania	*Rz*
Curly top resistance	intermediate
Bolting tendency	mod. resistant
Virus yellows resistance	intermediate
Erwinia	resistant
Powdery mildew	intermediate
Sugar type	EN

Popn-931 developed & improved from 1970 to present as popns-747,-903,-909,-911,-912,-913,-915,-918,&-925.

From popn-931 as the primary base, additional populations have been generated by introgressing new or useful germplasm. For example, to improve sucrose concentration, popn-Z31 and popn-930 were developed that have 50% and 25% Polish-ZZ germplasm, respectively. Popns-926, -927,& -928 have resistance to rhizomania from *B.v.maritima*. Popn-CR11 has resistance to Cercospora leaf spot from Italian accessions.

POPULATION-931 BASED POPULATIONS

Population	Emphasis/Germplasm
931	*Rz base population*
924	VYR
926,927,928	RZM,VYR from *Bvm*
929	VYR from C31 *Rz*-types
930	VYR, %S from C78 x ZZ
932	CTR
933	Root aphid resistance, CLSR
CR11	CLSR from Italian gp
Z31	%S, ZZ-Polish gp

The performance of popn-931 and its subpopulations are shown in the chart below. In comparison to the mean of three commercial hybrids, these populations perform quite well. This high performance suggests that those populations might be useful sources for the extraction and evaluation of progeny lines for further population improvement and identification of potentially useful parental (pollinator) lines.

POPULATION IMPROVEMENT – MM,S^f,GENETIC MS FACILITATED,RANDOM-MATED POPULATIONS,Salinas, 1998

Popu-lation	Objective	Sugar Yield (lbs/a) Nondis.	Rhizom.	VY
Check	Commercial hybrids[1]	15800	13000	8000
Combined resistance & productivity				
931	*Rz* base population	15800	13500	9900
Combined resistance				
926	R22(*Bmv*) rzm resist.	15600	12900	10000
924	Virus yellows	14500	12800	9500
932	Curly top, % sugar	12100	10600	8500
Z31	% sugar (Polish)	15900	13700	9500
CR11	Cercospora leaf spot	14400	12400	7600
N24	Cyst nematode	12900	12000	7600
LSD (.05)		1000	1000	800

[1]Mean of Beta 4035R, Rizor, Beta 4776R

These and similar populations were chosen as the source for population improvement using S_1 progeny evaluation. For this breeding design, in the 2nd year, S_1 progenies are evaluated per se. Based upon the results of these tests. About 20% of the S_1's are recombined and the superior 5% are selected to be increased and simultaneously test crossed to a common monogerm (*mm*) CMS tester to produce experimental test cross hybrids for evaluation in the 4th year.

ONE CYCLE OF POPULATION IMPROVEMENT	
Year	
	SOURCE POPULATIONS & BREEDING LINES
1	PROGENY PRODUCED (S_1, FS, HS)
2	PROGENY TESTS (Salinas, Brawley, Davis)
	➢ Components of Sugar Yield
	➢ Bolting
	➢ Reaction to Diseases
3	TESTCROSS HYBRIDS PRODUCED
4	TESTCROSS HYBRID TESTS (Salinas, Brawley)
	➢ Combining Ability for Sugar Yield
	➢ Bolting
	➢ Reaction to Diseases
5	RECOMBINE & INCREASE SELECTED PROGENY

Because S_1 seed is pivotal for this particular method of population improvement, breeding and selfing procedures were worked out in the greenhouse so that at least 12 grams of seed could be produced on each S_o plant under one paper bag. The S_o plants were either randomly chosen or were mother roots selected for some particular trait(s), for example, resistance to rhizomania. This 12 grams of seed is then allocated to progeny tests with sufficient remaining seed for Oregon steckling production nurseries. The stecklings are used to increase the chosen S_1 lines and to make the individual testcrosses. In case of crop failure, sufficient remnant seed is retained to repeat the steckling nursery if necessary.

ALLOCATION OF PROGENY SEED

Population -- ⊗ → S_1 progeny ($\geq$ 12 grams seed)

Seed Wt.	No. Reps.	Test/Nursery
3 g	3	November planted bolting/disease eval.
3	3	March planted Yield/VY test
3	3	April planted RZM/disease eval.
2		Steckling nursery
1		Remnant

The following two tables show the performance and dispersion of 124 S_1 progenies per se from popn-931 in tests at Salinas in 2000 under both rhizomania and nonrhizomania conditions. These dispersions suggest that sufficient genetic variability occurred to make progress.

PERFORMANCE OF 124 S_1 PROGENY FAMILIES FROM POPULATION-931, 2000, RHIZOMANIA

Trait	S_1 Mean	% of Mean: S_1 Range	% of Mean: LSD(.05)
Sugar Yield (lbs/a)	5300	30-172	53
Root Yield (t/a)	16.4	32-168	53
% Sugar	16.2	60-112	8
RJA Purity	82.5	77-108	6
		Actual	
% Bolting	19.4	0-100	16
Powdery Mildew Score	4.7	1- 9	3
Downy Mildew %	16.2	0- 74	24

Test 5800: 128v x 3r,RCB. Pltd.5-1-00. Harv.11-2-00.

PERFORMANCE OF 124 S_1 PROGENY FAMILIES FROM POPULATION-931, 2000, NONDISEASED

Trait	S_1 Mean	% of Mean: S_1 Range	% of Mean: LSD(.05)
Sugar Yield (lbs/a)	16000	77-124	20
Root Yield (t/a)	49.4	78-124	20
% Sugar	16.1	87-111	7
RJA Purity	82.5	96-104	4

Test 1800: 12v x 3r,RCB. Pltd.3-3-00. Harv.10-11-00.

Based upon these data obtained in 2000, a selection index of about 20% was used and in 2001 the selected S_1 progenies were recombined to form the next cycle synthetic. In addition, about 5% of the superior S_1 progenies were selected, increased individually, and crossed to a monogerm CMS tester to produce testcross hybrids. These experimental hybrids will be evaluated in 2002 for sugar yield combining ability (hybrid performance), bolting and disease resistance, and adaptation.

Because as yet hybrid data have not been obtained from these S_1 progenies from popn-931, test cross hybrids evaluated in 2000 from earlier evaluations will be presented here. These examples involve selections from populations 927,929, and 930.

TESTCROSS HYBRID PERFORMANCE
Brawley, 2000

Hybrid	Description	Sugar lbs/a	%S	% Bolt.
Check	Comm. hybrids[1]	11000	16.1	1.0
CMS x Sel'd S_1				
CMS x 927- 4	VY,RZM from *Bvm*	12400	16.3	1.5
CMS x 929-62	VY,RZM from C31*Rz*	13700	16.0	0.5
CMS x 930-35	VY,RZM from Z31*Rz*	11800	17.4	0.3
LSD (.05)		1200	.7	3.7

Mean of tests B300 & B600: pltd. Sept. '99; harv. June '00.
[1]Mean of Alpine, Phoenix, Beta 4776R, Beta 4430R.

TESTCROSS HYBRID PERFORMANCE, RHIZOMANIA
Salinas, 2000

Hybrid	Description	Sugar lbs/a	%S	% Bolt.
Check	Comm. hybrids[1]	9000	16.0	32
CMS x Sel'd S_1				
CMS x 927- 4	VY,RZM from *Bvm*	11200	15.3	14
CMS x 929-62	VY,RZM from C31*Rz*	9300	15.4	1
CMS x 930-35	VY,RZM from Z31*Rz*	9500	16.4	18
LSD (.05)		1100	.6	15

Test 6900: pltd. 5-2-00; harv. 10-19-00.
[1]Mean of Alpine, Phoenix, Beta 4776R, Beta 4430R.

TESTCROSS HYBRID PERFORMANCE, NONDISEASED
Salinas, 2000

Hybrid	Description	Sugar lbs/a	%S	% Bolt.
Check	Comm. hybrids[1]	19200	17.2	32
CMS x Sel'd S_1				
CMS x 927- 4	VY,RZM from *Bvm*	19300	16.7	14
CMS x 929-62	VY,RZM from C31*Rz*	19100	16.5	1
CMS x 930-35	VY,RZM from Z31*Rz*	18000	17.4	18
LSD(.05)		1200	0.5	15

Test 3000: pltd. 3-22-00; harv. 9-26-00.
[1]Mean of Alpine, Phoenix, Beta 4776R, Beta 4430R.

Line 927-4 has a germplasm component for improved resistance to rhizomania from wild beet through line C51 and is being released in 2002 as C927-4 (see description above).

Line 929-62 was from a population with introgressed resistance to virus yellows and is being released as C929-62 (see description above).

Line 930-35 was from popn-930 that has 25% of its germplasm from Polish-ZZ sources and is being released as C930-35 (see description above).

Results from 2001 tests at Salinas and Brawley of these lines and others are shown throughout this Report.

INDEX OF VARIETY TRIALS, SALINAS, CA, 2001
U.S. AGRICULTURAL RESEARCH STATION

Tests were located in three field plot areas at Salinas and two at Brawley, CA. Disease nurseries were also used in Idaho, Colorado, and Minnesota. Tests at Brawley (Imperial Valley) were planted in September 2000, and harvested from May through June, 2001. Tests at Salinas were planted from November, 2000 through August, 2001, and harvested from September through December. Tests at Spence Field (Salinas) were under both rhizomania and nonrhizomania (following methyl bromide fumigation) conditions. Herbicides were not used in Block 5 trials that followed strawberries and methyl bromide fumigation. Nortron, Pyramin, Betamix, Progress, and Poast were used in the other trials. Bayleton at 2lbs material/acre was used for powdery mildew control. Lorsban-4E was applied for aphid and other insect control. The specific planting and harvest dates as well as plot size and design are shown on each test summary.

Tests are listed in the main Table of Contents for Salinas by types of material and evaluation. As an aid to find test summaries, they are listed below by ascending test (planting date) number and cross- referenced to the page number. Tests shown as N/A are not available or not included in this report.

Test results shown as C are combined and summarized across tests.

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
NOVEMBER PLANTED BOLTING EVALUATION, 2000			
101	100	Experimental hybrids	A136
201	100	Lines and populations	A143
301	40	Increase of selected progeny lines	A148
401	40	Hybrids of selected progeny lines	A414
501	96	Full-sib progenies from Y75,Y67,Y71	C
601	96	Full-sib progenies from C69,R70	C
701	64	Full-sib progenies from C78,C80	C
801	64	BC families with PM resistance	C
901	64	S_1 progenies from 931, 941	C
1001	64	S_1 progenies from 933	C
1101	32	Monogerm, S_1 progenies	C
1201	96	S_1mmaa x C78 topcross hybrids	C
NONDISEASED YIELD & PROGENY TESTS, MARCH 2001			
1401	48	Monogerm lines & population	A42
1501	96	Full-sib progenies from Y75,Y67,Y71	C
1601	96	Full-sib progenies from C69,R70	C

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
NONDISEASED YIELD & PROGENY TESTS, MARCH 2001 (cont.)			
1701	64	Full-sib progenies from C78,C80	C
1801	64	BC families with PM resistance	C
1901	64	S_1 progenies from 931,941	C
2001	48	S_1 progenies from 933	C
2201	48	Increase of selected progeny lines	A33
2301	24	Lines and populations	A35
2401	24	Commercial hybrids (Not VY inoc.)	A48
2501	24	Experimental hybrids (Not VY inoc.)	A50
2601	12	Smooth root germplasm (Not VY inoc.)	A45
2701	48	Lines and populations	A36
2801	24	Commercial hybrids	A48
2901	24	Experimental hybrids	A50
3001	12	Smooth root germplasm	A46
3101	12	Retest of S_1mmaa x C69	A52
3201	24	Experimental hybrids	A53
3301	48	Test cross hybrids with FS progeny	A55
3401	48	Test cross hybrids with S_1 progeny	A58
3501	96	S_1mmaa x C78 topcross hybrids	C
DISEASE EVALUATION TRIALS, APRIL, 2001			
4101	129	Segregation & Inheritance of PM resistance	n/a
4201-1	64	Coded hybrid powdery mildew	A129
4301	40	Erwinia/PM evaluation of progeny lines	A117
4401	100	Erwinia/PM evaluation of lines	A119
4501	40	Erwinia/PM evaluation of progeny hybrids	A123
4601	80	Erwinia/PM evaluation of hybrids	A125
4701		Cercospora/rhizomania of lines	A131
RHIZOMANIA YIELD, EVALUATION, SELECTION TRIALS, APRIL, 2001			
5101	48	Plant Introduction evaluation	A150
5201-1	24	Nematode, PM, RZM observation	n/a
5201-2	12	Observation of monogerm lines	n/a
5301	15	RZM resistant mother root selection	n/a
5401	48	Monogerm lines and populations	n/a
5501	96	Full-sib progenies from Y75,Y67,Y71	n/a
5601	96	Full-sib progenies from C69,R70	n/a
5701	64	Full-sib progenies from C78,C80	n/a
5801	---	Seedex observation and selection	n/a
5901	64	S_1 progenies from 931,941	n/a
6001	48	S_1 progenies from 933	C
6101	---	Holly Hybrids observation	n/a
6201	48	Increase of selected progeny lines	n/a
6601	12	Smooth root germplasm	A47

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
RHIZOMANIA YIELD, EVALUATION, SELECTION TRIALS, APRIL, 2001 (cont.)			
6701	48	Lines and populations	A39
6801	72	CBGA Coded RZM test	A75
6901	36	Western Sugar, Michigan Sugar, Holly Sugar test	A72
7001	24	Experimental hybrids	A61
7101	12	Retest of S_1mmaa x C69 topcrosses	A63
7201	12	Monogerm x C78 topcross hybrids	A64
7301	48	Test cross hybrids with FS progeny	A65
7401	48	Test cross hybrids with S_1 progeny	A68
7501	96	S_1mmaa x C78 topcross hybrids	C
7601	16	Experimental hybrids with elite progeny	A71
REPLANT OF RHIZOMANIA TESTS, JUNE, 2001			
5101-2	48	Replant of PI evaluation	A150
5201-3	24	Replant of Nematode observation	n/a
5801-2	---	Replant of Seedex observation	n/a
RHIZOMANIA SELECTION (STECKLINGS, 2001 SEED), AUGUST, 2001			
8101	294	Rhizomania selection for stecklings	n/a
9101	154	Rhizomania selection for stecklings	n/a
IMPERIAL VALLEY, BRAWLEY, CA, 2000-2001			
NONRHIZOMANIA YIELD TESTS, FIELD J, SEPTEMBER, 2000			
B101	24	Experimental hybrids	A79
B201	48	Testcross hybrids with FS progeny	A81
B301	48	Testcross hybrids with S_1 progeny	A83
B401	27	Area 5 Mid-harvest Coded test	A86
RHIZOMANIA YIELD (MILD), FIELD K, SEPTEMBER, 2000			
B501	48	Testcross hybrids with S_1 progeny	A90
B601	48	Testcross hybrids with FS progeny	A93
B701	96	S_1mmaa x C78 topcross hybrids	C
B801	96	Full-sib & S_1 progeny evaluation	A96
RHIZOMANIA OBSERVATION (SEVERE), FIELD K, SEPTEMBER, 2000			
B1001	80	Evaluation Experimental hybrids	A101
B1101	64	Evaluation lines and populations	A104
B1201	256	Progeny evaluation	n/a

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
POWDERY MILDEW CONTROL (Turini, Gerik, Lewellen)			A109
TRANSGENIC HERBICIDE TEST, FIELD J, SEPTEMBER, 2000			
B901	8	Herbicide resistant hybrids	A107
BEET CURLY TOP NURSERY, BSDF, KIMBERLY, IDAHO, 2001			
USDA	180	Beet curly top nursery	A111
CERCOSPORA LEAF SPOT, FORT COLLINES & SHAKOPEE			
USDA	20	USDA entries in CR tests	A135

DATA FROM COMBINED PROGENY TESTS FOR NB, %S, RZM, etc.

Combined Tests	Test Description	
501, 1501	FS progeny from Y75, C67, Y71, R43	A153
601, 1601	FS progeny from C69, R70	A158
701, 1701	FS progeny from C78, C80	A162
801, 1801	BC families from P29, P30, P27, P28	A165
901, 1901	S_1 progeny from popn-931, -941, -934	A168
1001, 2001, 6001	S_1 progeny from popn-933	A171
1101	S_1 progeny from FC123, C869, 840	A173
1201, 3501, 7501, B701	Test cross hybrids of S_1mmaa x C78	A175

TEST 2201. EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 2001

48 entries x 4 reps., sequential
1-row plots, 11 ft. long

Planted: March 23, 2001
Harvested: October 4, 2001

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100′	Powdery Mildew	RJAP
		Lbs	Tons	%	No.	10/01	%
Checks							
00-US75	Inc. 97-US75	13698	44.35	15.40	148	8.3	85.8
00-C37	Inc. U86-37, C37	13544	40.72	16.63	148	8.3	86.5
R076-89-5	Inc. R876-89-5, C76-89-5	14107	39.51	17.83	132	1.8	87.1
Beta 6600	L9N490018AA, 7-11-00,%S check	17300	45.15	19.20	143	4.8	88.0
Source popns & Increases of S_1 lines							
0941	RZM 9941aa x A,(popn-941)	17106	49.99	17.10	141	4.3	86.1
0934-5	Inc. 8934-5 (A,aa)	13844	38.70	17.90	150	5.8	86.1
0935-25	Inc. 8935-25 (A,aa)	14678	39.51	18.58	155	2.0	86.9
0936-8	Inc. 8936-8 (A,aa)	15245	40.72	18.73	143	1.5	88.7
0936-10	Inc. 8936-10 (A,aa)	16648	47.57	17.58	143	2.0	87.5
0936-11	Inc. 8936-11 (A,aa)	14345	41.52	17.27	159	1.8	88.6
0936-16	Inc. 8936-16 (A,aa)	13843	36.69	18.90	145	0.3	84.2
CR009-1	RZM CR909-1aa x A, (CR09-1)	15816	43.34	18.25	150	4.3	84.8
Z025-9	Z825aa x A, (CZ25-9)	14637	38.14	19.20	152	2.0	84.3
0931	RZM 9931aa x A,(popn-931)	19342	56.04	17.25	145	5.3	87.5
0931-5	Inc. 8931-5 (A,aa)	15657	44.95	17.40	150	7.0	86.0
0931-7	Inc. 8931-7 (A,aa)	15544	43.06	18.05	134	4.5	84.7
9924-2	Inc. 7924-2 (A,aa)	14749	40.48	18.20	134	2.3	87.7
9927-4	Inc. 7927-4VY (A,aa), (C927-4)	14700	43.94	16.70	139	7.0	88.0
9929-4	Inc. 7929-4VY (A,aa)	13371	40.72	16.38	143	3.0	84.7
9929-45	Inc. 7929-45VY (A,aa)	14989	43.94	17.00	150	2.8	87.7
9929-47	Inc. 7929-47VY (A,aa)	12665	37.09	17.05	143	5.3	86.6
9929-62	Inc. 7929-62 (A,aa), (C929-62)	17231	50.80	16.97	166	1.0	88.1
9930-35	Inc. 7930-35 (A,aa), (C930-35)	14641	37.90	19.33	166	5.5	85.5
0927-29	8927-29aa x A	13186	37.90	17.40	155	3.8	86.3
0929-112	8929-112aa x A	15776	42.73	18.45	148	5.8	86.5

TEST 2201. EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100′	Powdery Mildew	RJAP
		Lbs	Tons	%	No.	10/01	%
Source popns & S_1 lines (cont.)							
0929-114	8929-114aa x A	15445	42.17	18.30	143	2.3	86.4
0930-19	8930-19aa x A,(C930-19)	16249	44.75	18.10	141	2.3	88.9
Increases of Multigerm, self-sterile, full-sib lines							
R070-9	Inc. R870-9	15871	43.54	18.25	157	5.8	85.5
R076-89-5-9	Inc. R876-89-5NB-9	12469	34.27	18.17	159	0.8	85.9
R078-3	Inc. R878-3	15388	43.54	17.70	157	3.5	85.9
R078-4	Inc. R878-4	17830	51.40	17.35	157	2.0	89.0
R078-8	Inc. R878-8	17333	50.80	17.02	155	3.8	87.6
R078-9	Inc. R878-9	15765	43.54	18.10	155	4.3	88.1
R080-5	Inc. R880-5	16046	45.56	17.63	152	8.8	87.5
R080-9	Inc. R880-9	15401	42.53	18.13	145	4.5	87.5
R080-13	Inc. R880-13	15057	42.73	17.60	150	6.8	86.6
R080/2-9	Inc. R880/2-9	16341	44.35	18.40	155	7.3	85.6
R080/2-11	Inc. R880/2-11	14992	42.73	17.52	139	5.5	85.7
R080-45-10	Inc. R880-45-10	15088	42.33	17.85	139	1.3	89.2
Y067-3	Inc. Y867-3	14683	44.10	16.63	145	5.5	88.3
Y068- 1	Inc. Y868- 1	13122	37.90	17.30	148	4.0	89.6
Y068- 2	Inc. Y868- 2	14958	43.34	17.25	150	4.8	88.4
Y068- 4	Inc. Y868- 4	14469	42.33	17.05	148	4.5	85.7
Y068- 6	Inc. Y868- 6	16250	45.96	17.70	161	5.0	86.8
Y069-13	Inc. Y869-13	15793	43.94	17.98	143	4.5	88.2
Y069-18	Inc. Y869-18	16180	47.09	17.20	159	3.0	87.7
Y069-26	Inc. Y869-26	14592	43.94	16.50	155	3.3	86.1
Y072- 4	Inc. Y872- 4	15912	44.35	17.92	134	4.5	89.2
Mean		15247.8	43.18	17.67	148.5	4.1	86.9
LSD (.05)		2338.3	5.94	0.90	19.8	2.1	3.0
C.V. (%)		11.0	9.83	3.65	9.6	36.4	2.5
F value		2.7**	3.81**	6.05**	1.3NS	7.8**	1.7**

Note: Nonrhizomania test of increases of selected progeny lines. Rhizomania test not harvested.

TEST 2301. PERFORMANCE OF LINES, SALINAS, CA, 2001

24 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 23, 2001
Harvested: October 3, 2001

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Powdery Mildew 10/01	RJAP
		Lbs	Tons	%	No.		%
00-SP22-0	Inc. 97-SP22-0	13003	39.54	16.41	156	5.0	88.1
00-US75	Inc. 97-US75	12495	41.72	14.95	148	8.5	84.8
00-C37	Inc. U86-37,C37	12810	39.60	16.09	152	8.8	86.2
99-C46/2	Inc. U86-46/2, C46/2	15513	44.64	17.35	153	5.1	87.7
R078	Inc. R978,C78	15740	44.84	17.55	156	2.6	87.4
Y090	Inc. Full-sib progeny composite	16983	47.06	18.04	157	5.0	87.2
Y969	RZM-ER-% Y769,C69	16837	46.42	18.13	150	3.9	88.1
99-C31/6	Inc. F86-31/6, C31/6	13642	42.58	15.98	151	4.4	87.5
R076-89	RZM R976-89R	15781	45.92	17.19	155	2.8	87.5
R076-89-5	Inc. R876-89-5, C76-89-5	14673	40.81	17.98	158	3.3	87.8
R976-89-18	Inc. R576-89-18, C76-89-18	14836	44.64	16.60	149	5.0	88.0
Beta 6600	L9N490018AA, 7-11-00	17103	43.64	19.55	161	6.4	90.6
R881	RZM R776,R781,…,C82	15830	47.16	16.79	156	5.3	87.1
R039	Inc. R539 (C39R), C39R	14124	42.33	16.67	153	2.6	88.4
R980	RZM-ER-% R780/2,…,C80	17353	48.47	17.89	157	3.3	87.3
Beta 4776R	911158FH2, 3-2-00	17986	50.59	17.80	160	3.1	88.9
R021	RZM R926,R927,(C26,C27)	15897	46.66	17.04	148	6.3	86.1
Y067	RZM Y967,C67	15784	44.24	17.85	149	4.1	86.4
Y071	RZM Y971	15744	46.46	16.94	154	7.4	85.3
Y075	RZM-% Y875	16222	45.85	17.66	149	5.0	85.9
0931	RZM 9931aa x A, (popn-931)	17364	50.39	17.23	147	4.3	86.8
0941	RZM 9941aa x A, (popn-941)	17287	50.99	16.94	152	4.1	86.9
0942	RZM-% R576-89-18H18,19	15893	45.55	17.46	155	1.9	85.7
Phoenix	Spreckels, Feb 2001	19400	54.52	17.79	164	5.1	89.3
Mean		15762.5	45.61	17.24	153.7	4.7	87.3
LSD (.05)		1186.9	2.35	0.85	10.3	1.2	2.0
C.V. (%)		7.6	5.24	5.07	6.8	26.3	2.3
F value		16.0**	18.95**	8.82**	1.6*	16.6**	3.5**

NOTE: See tests 2701 and 6701. Test 2301 was not inoculated with BChV as originally planned.

TEST 2701. PERFORMANCE OF LINES, SALINAS, CA, 2001

48 entries x 8 reps, RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2001
Harvested: September 26-27, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
2701-1: Multigerm, O.P. Lines						
Beta 6600	L9N490018AA, 7-11-00	15893	42.43	18.70	157	0.0
97-US22/3	Inc. Y009 (US22/3)	12094	36.48	16.52	155	0.0
00-US75	Inc. 97-US75	11017	38.90	14.13	153	0.0
00-C37	Inc. U86-37, C37	11959	37.89	15.68	154	0.0
99-C46/2	Inc. U86-46/2, C46/2	14756	44.64	16.55	155	0.0
R078	Inc. R978, C78	15956	46.36	17.21	157	0.0
R980	RZM-ER-% R780/2,…,C80	15715	45.15	17.41	155	0.0
Y090	Inc. Full-sib progeny composite	14974	43.33	17.26	153	0.0
Y969(Iso)	RZM-ER-% Y769, C69	14985	43.07	17.40	150	0.0
99-C31/6	Inc. F86-31/6,C31/6	13996	43.03	16.27	154	0.0
R881	RZM R776,R781,…,C82	15677	46.56	16.85	159	0.0
R076-89	RZM R976-89R	14405	42.63	16.88	153	0.0
R076-89-5	Inc. R876-89-5, C76-89-5	12997	37.39	17.39	152	0.0
R976-89-18	Inc. R576-89-18, C76-89-18	13163	39.96	16.46	143	0.0
R039	Inc. R539 (C39), C39R	13018	41.42	15.65	155	0.0
Beta 4776R	911158FH2, 3-2-00	16222	45.85	17.69	163	0.0
Mean		14176.7	42.19	16.75	154.2	-.-
LSD (.05)		1489.2	3.31	0.95	8.1	-.-
C.V. (%)		10.6	7.93	5.72	5.3	-.-
F value		9.3**	7.54**	9.35**	2.3*	-.-

TEST 2701. PERFORMANCE OF LINES, SALINAS, CA, 2001
48 entries x 8 reps, RCB(E). ANOVA across tests to compare means.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Bolting %
Mean	14892.9	44.13	16.85	154.0	0.4
LSD (.05)	1236.2	3.08	0.70	8.2	1.0
C.V. (%)	8.4	7.08	4.24	5.4	243.8
F value	10.8**	9.15**	7.82**	1.4*	16.8**

TEST 2701. PERFORMANCE OF LINES, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
2701-2: Multigerm lines with *Bvm* germplasm						
Beta 4430R	010269FH2, 9-8-00	18182	51.80	17.55	156	0.0
HH142	Spreckels, 9-7-00	16985	48.27	17.58	155	0.0
00-EL0204	RZM 99—EL0204	15128	47.67	15.91	154	0.0
00-SP22-O	Inc. 97-SP22-0	12118	38.29	15.82	152	0.0
R036	RZM R936, C79-8	13402	41.32	16.24	153	0.0
R021	RZM R926,R927, (C26,C27)	14821	44.64	16.60	152	0.0
Y067	RZM Y967,C67	14251	40.91	17.41	152	0.0
Y071	RZM Y971	15124	44.74	16.90	156	0.0
Y075	RZM-%S Y875	14824	44.14	16.84	156	0.0
P007	PMR-RZM P907	15444	45.45	17.00	159	0.0
P007/8	PMR-RZM P807-2,-8;P808-7	15484	44.95	17.23	159	0.0
P012	PMR-RZM P912	14265	43.43	16.45	153	0.4
P017	PMR-RZM P917-#(C),(WB97)	14838	44.44	16.71	155	5.6
P018	PMR-RZM P918-#(C),(WB242)	15204	45.35	16.77	155	6.3
P019	PMR-RZM P919-#(C),(WB97)	15942	46.26	17.21	151	0.0
P020	PMR-RZM P920-#(C),(WB242)	15675	46.96	16.71	158	6.6
Mean		15105.5	44.91	16.81	154.7	1.2
LSD (.05)		1044.7	3.04	0.51	7.1	1.7
C.V. (%)		7.0	6.85	3.09	4.7	147.4
F value		13.3**	8.38**	8.23**	0.9NS	16.3**

TEST 2701. PERFORMANCE OF LINES, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
2701-3: Multigerm, S^f, Aa populations						
Phoenix	Spreckels, Feb.2001	17302	49.88	17.34	159	0.0
0931	RZM 9931aa x A	16794	48.57	17.30	153	0.0
0941	RZM 9941aa x A	15671	46.29	16.92	152	0.0
0942	RZM-% R576-89-18H18,19	15202	44.04	17.26	153	0.0
9933	8933aa x A	16938	48.78	17.35	155	0.0
0747	Inc. 7747 (A,aa)	13948	43.94	15.86	156	0.0
CR011	RZM CR910,911,912aa x A	15478	45.15	17.13	151	0.0
Z025	RZM Z925,Z931aa x A	16073	46.26	17.41	153	0.0
0934	RZM 9934 (A,aa)	14460	44.26	16.34	151	0.0
0936	Inc. 8936 (A,aa)	15022	44.54	16.88	157	0.0
0921	RZM 9926aa x R926,7	16005	46.46	17.21	144	0.0
0926	RZM-% 8926 (A,aa)	15322	45.95	16.70	154	0.0
CR009-1	RZM CR909-1aa x A	12824	36.88	17.41	150	0.0
N024	RZM N925,…#(C)(galls)(A,aa)	15003	44.34	16.91	153	0.0
0835(Sp)	RZM 9833,9835mmaa x A	15517	45.45	17.08	159	0.0
0836	RZM 9836,9836(C)mmaa x A	14788	43.64	16.93	153	0.0
Mean		15396.7	45.28	17.00	153.3	-.-
LSD (.05)		1133.2	3.04	0.57	8.2	-.-
C.V. (%)		7.4	6.79	3.38	5.4	-.-
F value		7.8**	7.17**	4.30**	1.6NS	-.-

Notes: Also see test 2301 and 6701 (with rhizomania). Tests 2301 and 2701 were designed to be companion tests to evaluate reaction to *Beet chlorosis virus*. The virus inoculation was not done. See tests 2401 and 2801 for plot history. There was very little disease pressure for tests 2301 and 2701 and no rhizomania observed. Test 6701 had moderate to severe rhizomania.

TEST 6701. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA, 2001

48 entries x 8 reps., RCB(E); 3 subtests 16 x 8, RCB(E) — Planted: May 01, 2001
1-row plots, 22 ft. long — Harvested: October 29, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %	RJAP %
6701-1: Multigerm, O.P. Lines							
Beta 6600	L9N490018AA, 7-11-00	7126	19.72	18.05	203	0.0	89.9
97-US22/3	Inc. Y009 (US22/3)	5161	15.26	16.95	184	0.0	87.0
00-US75	Inc. 97-US75	6265	19.98	15.71	188	0.0	86.7
00-C37	Inc. U86-37, C37	5473	16.91	16.23	194	0.0	86.1
99-C46/2	Inc. U86-46/2, C46/2	7034	20.62	17.06	194	0.0	87.1
R078	Inc. R978, C78	8746	24.39	17.95	187	0.0	86.5
R980	RZM-ER-% R780/2,…,C80	9304	25.75	18.06	194	0.0	86.0
Y090	Inc. Full-sib progeny composite	9764	27.06	18.10	203	0.0	86.2
Y969(Iso)	RZM-ER-% Y769, C69	10170	27.96	18.16	187	0.0	86.8
99-C31/6	Inc. F86-31/6,C31/6	6112	18.54	16.48	174	0.0	88.0
R881	RZM R776,R781,…,C82	9456	27.28	17.34	191	0.0	87.0
R076-89	RZM R976-89R	8013	23.05	17.46	174	0.0	86.5
R076-89-5	Inc. R876-89-5, C76-89-5	8004	22.47	17.85	189	0.0	85.8
R976-89-18	Inc. R576-89-18, C76-89-18	6671	19.37	17.21	145	0.0	86.5
R039	Inc. R539 (C39), C39R	9223	26.20	17.61	184	0.0	86.0
Beta 4776R	911158FH2, 3-2-00	10978	30.03	18.36	207	0.0	88.4
Mean		7968.7	22.79	17.41	187.4	-.-	86.9
LSD (.05)		898.7	2.58	0.46	16.2	-.-	1.8
C.V. (%)		11.4	11.42	2.65	8.7	-.-	2.1
F value		30.4**	22.32**	22.12**	6.4**	-.-	2.8**

TEST 6701. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA, 2001
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Bolting %	RJAP %
Mean	8782.4	25.30	17.34	188.2	0.2	86.7
LSD(.05)	1031.2	2.99	0.53	17.2	0.6	1.8
C.V. (%)	11.9	12.01	5.77	9.3	271.2	2.1
F value	17.1**	13.42**	13.72**	2.5**	17.0**	3.3**

TEST 6701. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolting %	RJAP %
6701-2: Multigerm lines with *Bvm* germplasm							
Beta 4430R	4-13-01	10308	27.60	18.77	189	0.0	88.9
HH142	Spreckels, 9-7-00	10127	27.68	18.34	174	0.0	86.9
00-EL02/04	RZM 99-EL0204	9847	29.40	16.74	184	0.0	88.1
US H11	11-3-99	5286	16.93	15.56	184	0.0	86.9
R036	RZM R936, C79-8	7913	24.42	16.24	181	0.0	85.4
R021	RZM R926,R927, (C26,C27)	9264	26.81	17.33	191	0.0	87.4
Y067	RZM Y967,C67	9330	26.46	17.66	189	0.0	85.3
Y071	RZM Y971	9171	26.60	17.27	190	0.0	87.7
Y075	RZM-%S Y875	9647	27.34	17.71	189	0.0	86.3
P007	PMR-RZM P907	9192	26.43	17.50	194	0.0	86.4
P007/8	PMR-RZM P807-2,-8;P808-7	10578	29.48	17.99	184	0.0	85.9
P012	PMR-RZM P912	8556	26.04	16.45	174	0.0	84.3
P017	PMR-RZM P917-#(C),(WB97)	8318	24.81	16.81	194	3.0	85.9
P018	PMR-RZM P918-#(C),(WB242)	10210	30.13	16.94	192	3.2	86.0
P019	PMR-RZM P919-#(C),(WB97)	10937	30.77	17.80	192	0.0	87.6
P020	PMR-RZM P920-#(C),(WB242)	9524	27.43	17.44	196	4.0	86.7
Mean		9262.9	26.8	17.28	187.3	0.6	86.6
LSD (.05)		1018.3	2.9	0.53	15.8	1.0	1.9
C.V. (%)		11.1	10.8	3.11	8.5	155.8	2.3
F value		13.6**	9.7**	18.25**	1.4NS	15.54**	2.8**

TEST 6701. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolting	RJAP
		Lbs	Tons	%	No.	%	%
6701-3: Multigerm,S^f,Aa populations							
Phoenix	Spreckels, Feb.2001	9451	25.96	18.21	187	0.0	89.5
0931	RZM 9931aa x A	10929	31.42	17.42	181	0.0	87.4
0941	RZM 9941aa x A	10384	29.74	17.48	196	0.0	87.0
0942	RZM-% R576-89-18H18,19	9027	25.98	17.40	188	0.0	85.8
9933	8933aa x A	10350	30.13	17.23	193	0.0	86.4
0747	Inc. 7747 (A,aa)	6585	20.68	15.86	189	0.0	88.2
CR011	RZM CR910,911,912aa x A	9466	27.41	17.25	200	0.0	86.0
Z025	RZM Z925,Z931aa x A	9562	26.74	17.95	184	0.0	87.8
0934	RZM 9934 (A,aa)	8609	25.70	16.79	191	0.0	86.7
0936	Inc. 8936 (A,aa)	9666	27.31	17.71	191	0.0	86.4
0921	RZM 9926aa x R926,7	9843	28.82	17.11	200	0.0	85.9
0926M	RZM-% 8926 (A,aa)	9623	27.69	17.46	195	0.0	84.7
CR009-1	RZM CR909-1aa x A	7220	20.73	17.46	184	0.0	84.1
N024	RZM N925,…#(C)(galls)(A,aa)	8707	25.67	17.01	185	0.0	85.9
0835(Sp)	RZM 9833,9835mmaa x A	8559	24.46	17.54	187	0.0	87.8
0836	RZM 9836,9836(C)mmaa x A	7868	23.22	17.09	186	0.0	85.7
Mean		9115.4	26.35	17.31	189.8	-.-	86.6
LSD (.05)		947.7	2.74	0.54	17.8	-.-	1.8
C.V.(%)		10.5	10.50	3.12	9.5	-.-	2.1
F value		11.8**	9.74**	7.46**	0.8NS	-.-	4.3**

NOTES: Also see tests 2301 and 2701 without rhizomania. Test 6701 was grown under moderate rhizomania. In addition, other soilborne problems occurred including cyst nematode and damping off and root pruning from *Pythium, Aphanomyces* and others. Powdery mildew was controlled. A low incidence of *Sclerotium rolfsii* occurred.

TEST 1401. EVALUATION OF MONOGERM LINES AND POPULATIONS, SALINAS, CA., 2001

48 entries x 4 reps., sequential
1-row plots, 11 ft. long

Planted: March 23, 2001
Harvested: October 3, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Powdery Mildew 10/01	RJAP %
Checks							
0833-5(Sp)	RZM 9833-5(T-O)aa x A, (C833-5)	14504	39.50	18.33	150	4.5	85.2
99-790-68	Inc. U88-790-68, (C790-68)	10542	33.05	15.82	155	3.8	88.4
00-790-15	Inc. F92-790-15, (C790-15)	14128	45.15	15.45	152	4.3	88.6
00-790-15CMS	88-790-68CMS .x C790-15, (C790-15CMS)	15881	47.16	16.73	143	5.5	90.0
FC & EL monogerm lines							
00-FC123	RZM 99-FC123m	15065	43.86	17.17	145	5.0	86.5
00-FC1014M	RZM-% FC951014	15320	43.53	17.63	155	6.8	84.8
EL98J26-052mm	EL smooth root 3/01	12773	41.12	15.57	152	7.3	86.5
EL99J31-00mm	EL smooth root 3/01	12361	36.68	16.85	143	6.0	85.7
Monogerm lines, CMS's, & F_1's							
0833-5(Iso)	*RzRz*, T-O 8833-5(C), (C833-5)	12676	35.23	18.02	143	6.0	84.9
0833-5(Sp)	RZM 9833-5(T-O)aa x A, (C833-5)	15028	42.08	17.85	139	4.5	84.2
0833-5H0	RZM 9833-5(T-O)HO x ", (C833-5CMS)	15866	42.65	18.60	141	5.3	87.2
0833-5H50	C790-15CMS x C833-5(T-O)	17988	49.18	18.27	150	5.8	88.7
0833-5H45	RZM C867-1HO x C833-5(T-O)	16888	45.95	18.38	143	7.0	87.5
0833-5H46	RZM 9869-6HO x C833-5(T-O)	17445	47.89	18.25	145	9.0	87.6
0911-4-10m(Sp)	Inc. C911-4-10(C)mm	12853	34.22	18.80	145	4.3	83.9
0911-4-10H5	C833-5HO x C911-4-10(C)	19422	50.35	19.30	145	5.0	85.8
9831-3	RZM 8831-3 (C831-3)	14349	42.33	16.95	145	1.5	84.7
9831-4	RZM 8831-4 (C831-4)	16733	47.08	17.77	157	7.5	83.3
0831-4-7	Inbc. 9831-4-7	13662	38.70	17.65	157	6.5	80.5
0831-4-10	Inc. 9831-4-10	16272	46.11	17.63	148	7.3	81.3

TEST 1401. EVALUATION OF MONOGERM LINES AND POPULATIONS, SALINAS, CA., 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Powdery Mildew 10/01	RJAP %
Monogerm lines, CMS's, & F_1's (cont.)							
0833-10	RZM 9833-10 (A,aa)	12985	35.88	18.08	150	2.3	85.7
0834-2	Inc. 8834-2 (A,aa)	12977	36.68	17.70	152	5.8	86.3
0834-2H5	C833-5(T-O)HO x 8834-2	16193	44.74	18.13	148	6.0	86.6
0836-1M	Inc. 8836-1 (A,aa)	15568	45.55	17.10	148	5.0	85.1
0836-7	Inc. 8836-7 (A,aa)	14902	42.97	17.35	159	2.8	84.6
0837-6M	Inc. 8837-6 (A,aa)	14063	40.71	17.25	157	6.5	85.0
0808-9	Inc. 8808-9 (A,aa)	14705	40.47	18.17	155	5.0	87.0
0808-15	Inc. 8808-15 (A,aa)	14787	43.94	16.75	159	5.0	87.7
Monogerm populations							
N065M	RZM N965m (galls)	13639	44.34	15.40	155	6.0	83.2
N065H5	C833-5(T-O)HO x "	17009	48.37	17.60	148	5.5	89.6
9833	RZM 8833 (A,aa)	11575	36.68	15.77	148	8.5	85.1
9869	RZM-ER-% 7869NB (A,aa)	15063	45.28	16.65	141	6.5	86.8
9840	840(C)aa x A(C)	17033	50.47	16.85	150	7.3	85.2
0841HO	RZM 9840HO(A) x 841(C)	15859	47.97	16.50	141	6.5	85.6
0841H5	9833-5(T-O)HO x 841(C)	17690	50.67	17.45	155	8.3	86.7
0841H7	C833-5aa x 841(C)	16193	44.99	18.02	136	7.0	86.7
0841H35	9835T-Oaa x 841(C)	15318	46.36	16.55	159	8.3	88.1
0841H69	RZM 9869aa x 841(C)	14979	45.15	16.55	150	8.5	86.6
0835M	RZM-% 8835 (A,aa)	15086	43.53	17.33	155	7.5	85.9
0835NBM	NB-% 8835 (A,aa)	14593	42.73	17.08	161	8.0	86.2
0835 (Sp)	RZM 9833mmaa x A	16039	45.95	17.45	141	7.0	89.2
0835H5	C833-5(T-O)HO x 835(C)	15618	45.15	17.30	150	7.5	85.3
0836	RZM 9836mmaa x A	14423	41.92	17.13	139	8.3	87.3
0836H5	C833-5(T-O)HO x 9836	15821	46.24	17.13	134	7.8	85.6

TEST 1401. EVALUATION OF MONOGERM LINES AND POPULATIONS, SALINAS, CA., 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100′	Powdery Mildew	RJAP
		Lbs	Tons	%	No.	10/01	%
Monogerm populations (cont.)							
0838M	RZM-% 8838 (A,aa)	16037	47.16	16.90	143	7.3	86.1
0848M	RZM-% 8848, 8810 (A,aa)	14253	41.12	17.25	141	5.0	84.6
Hybrid checks							
R078H5	C833-5(T-O)HO x R978	18771	52.00	18.03	148	4.0	86.8
Beta 4776R	911158FH2, 3-2-00	20122	53.61	18.77	155	2.0	90.0
Mean		15230.4	43.80	17.36	148.5	6.0	86.1
LSD (.05)		2286.8	5.70	1.10	18.1	2.0	2.7
C.V. (%)		10.7	9.31	4.53	8.7	23.3	2.2
F value		5.5**	5.33**	5.09**	1.1NS	6.5**	4.3**

NOTES: This test provides an estimate of the per se performance of monogerm lines and populations under nearly disease free conditions. The corresponding test under rhizomania conditions was too severely damaged to harvest. Also see tests 101 for bolting tendency and 4401 for reaction to *Erwinia* and powdery mildew. Lines prefaced with "C" have usually been released from Salinas. In general, monogerm lines carry a 4-digit designation. The first digit is the year of seed production, e.g., 0 = 2000. Then, 700's are usually older lines susceptible to rhizomania. 800's are usually from the resistance to rhizomania program. Dash numbers usually signify a progeny selection of the base line or population. HO = CMS. Aa = genetic male sterility. aa x A = increase thru genetic male sterile plants. (A,aa) = increase of both fertile and sterile plants in bulk. Inc.= increase. RZM = selection for resistance to rhizomania.
N = cyst nematode resistant. FC & EL are Fort Collins and E.Lansing lines.

TEST 2601. PERFORMANCE OF SMOOTH ROOT LINES WITH BChV, SALINAS, CA, 2001

12 entries x 8 reps, RCB
1-row plots, 22 ft. long

Planted: March 23, 2001
Harvested: October 2, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Bolting %	Root Rot %	RJAP %
Checks									
00-SP22-0	Inc. 97-SP22-0	14162	44.04	16.08	154	87.7	0.0	0.4	3.8
Y090	Inc. Full-sib progeny composite	17607	50.19	17.55	152	87.3	0.0	0.0	4.0
Smooth Root Lines									
SR96 (95H56)	EL SR, 3-14-01	17244	47.11	18.30	156	88.0	0.0	0.0	4.6
SR95	EL SR, 3-14-01	16248	46.86	17.31	160	89.1	0.0	0.0	4.6
SR94	EL SR, 3-14-01	16202	46.86	17.27	158	87.6	0.0	0.0	3.8
SR93	EL SR, 3-14-01	13975	48.47	14.41	156	88.1	1.0	0.0	6.0
SR80	EL SR, 3-14-01	14831	47.67	15.54	156	88.2	0.0	0.0	4.5
SR87	EL SR, 3-14-01	15976	52.30	15.29	161	88.9	0.0	0.0	4.8
94HS25	EL SR, 3-14-01	14823	43.74	16.94	160	88.1	0.0	0.0	5.3
00-EL0204	RZM 99-EL02/04	18902	57.95	16.33	151	88.7	0.0	0.4	4.8
Hybrid Checks									
R076-89H50	C790-15CMS x RZM R976-89R	18634	55.22	16.84	161	87.6	0.0	0.0	4.4
Beta 4430R	010269FH2, 9-8-00	21237	59.66	17.80	157	88.7	0.0	0.0	3.5
Mean		16653.4	50.01	16.64	156.8	88.2	0.1	0.1	4.5
LSD (.05)		1291.9	2.48	0.95	7.9	1.9	0.4	0.4	1.3
C.V. (%)		7.8	4.98	5.74	5.0	2.2	478.9	660.7	29.8
F value		22.5**	35.21**	11.45**	1.5NS	0.7NS	4.2**	1.0NS	2.2*

NOTES: Tests 3001 and 2601 were set up as companion tests, 2601 to be inoculated with Beet chlorosis virus. Because of inoculum problems, 2601 was not inoculated. These two tests are thus duplicate tests and will also be analyzed as one 12 variety x 16 replication test. Also see tests 6601 (with rhizomania) and 4701 (with rhizomania and Cercospora).

00-SP22-0 = 2000 seed increase of pollinator of US H20. Y090 = C1,Syn1 from full-sib progeny selection. SR = smooth root germplasm from E. Lansing program. 00-EL0204 = rhizomania resistant selection from C80*Rz* x SR.

TEST 3001. PERFORMANCE OF SMOOTH ROOT LINES WITHOUT BChV, SALINAS, CA, 2001

12 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2001
Harvested: September 24, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
Checks						
00-SP22-0	Inc. 97-SP22-0	11963	37.33	16.00	156	0.0
Y090	Inc. Full-sib progeny composite	15019	42.53	17.65	159	0.0
Smooth Root Lines						
SR96 (95H56)	EL SR, 3-14-01	13490	37.12	18.16	157	0.0
SR95	EL SR, 3-14-01	12239	36.48	16.76	157	0.0
SR94	EL SR, 3-14-01	12656	36.23	17.46	160	0.0
SR93	EL SR, 3-14-01	13959	44.50	15.64	159	0.7
SR80	EL SR, 3-14-01	12069	38.80	15.55	159	0.0
SR87	EL SR, 3-14-01	12283	40.91	15.00	159	0.0
94HS25	EL SR, 3-14-01	11831	35.02	16.88	159	0.0
00-EL0204	RZM 99-EL02/04	15602	48.67	16.04	149	0.0
Hybrid Checks						
R076-89H50	C790-15CMS x RZM R976-89R	16549	48.17	17.19	159	0.0
Beta 4430R	010269FH2, 9-8-00	18145	50.69	17.89	160	0.0
Mean		13817.3	41.37	16.68	157.7	0.1
LSD (.05)		1249.7	2.98	0.76	7.5	0.4
C.V. (%)		9.1	7.23	4.55	4.8	642.8
F value		22.0**	26.78**	14.60**	1.2NS	2.3*

NOTES: Tests 3001 and 2601 were set up as companion tests, 2601 to be inoculated with Beet chlorosis virus. Because of inoculum problems, 2601 was not inoculated. These two tests are thus duplicate tests and will also be analyzed as one 12 variety x 16 replication test. Also see tests 6601 (with rhizomania) and 4701 (with rhizomania and Cercospora).

00-SP22-0 = 2000 seed increase of pollinator of US H20. Y090 = C1,Syn1 from full-sib progeny selection. SR = smooth root germplasm from E. Lansing program. 00-EL0204 = rhizomania resistant selection from C80*Rz* x SR.

TEST 6601. PERFORMANCE OF SMOOTH ROOT LINES UNDER RHIZOMANIA, SALINAS, CA, 2001

12 entries x 8 reps, RCB
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 29, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Checks						
US H11	11-3-99	3647	11.42	16.05	160	85.8
Y090	Inc. Full-sib progeny composite	5335	15.17	17.67	160	85.8
Smooth Root Lines						
SR96 (95H5L)	EL SR, 3-14-01	5118	14.53	17.59	178	85.8
SR95	EL SR, 3-14-01	5071	15.19	16.73	184	88.9
SR94	EL SR, 3-14-01	5597	16.40	17.11	179	87.8
SR93	EL SR, 3-14-01	5047	16.57	15.19	175	88.6
SR80	EL SR, 3-14-01	5378	17.45	15.44	170	86.4
SR87	EL SR, 3-14-01	5640	18.83	14.93	183	86.7
94H525	EL SR, 3-14-01	5174	15.79	16.31	187	86.9
99-EL0204	RZM 98-EL02/04	7054	21.01	16.75	161	87.4
Hybrid checks						
R076-89H50	C790-15CMS x RZM R976-89R	5005	14.25	17.41	147	85.4
Beta 4430R	4-13-01	5568	14.95	18.65	157	87.0
Mean		5302.8	15.96	16.65	170.2	86.9
LSD (.05)		1290.4	3.85	0.53	15.0	1.9
C.V. (%)		24.4	24.21	3.21	8.9	2.2
F value		2.8**	3.13**	35.04**	5.9**	2.8**

NOTES: Also see tests 2601, 3001, and 4701. Test 6601 was grown under rhizomania conditions. In addition, other soilborne problems occurred (sugarbeet cyst nematode, *Pythium*, maybe *Aphonomyces*, etc.). See test 4701 for better test under just rhizomania. Except for %S, test 6601 is probably not very reliable.

TEST 2401-2801. PERFORMANCE OF COMMERCIAL HYBRIDS, SALINAS, CA, 2001

24 entries x 16 reps, RCB
1-row plots, 22 ft. long

Planted: March 23, 2001
Harvested: September 25, 2001
& October 2, 2001

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Lbs	Tons	%	No.	%
Checks						
Beta 6600	L9N490018AA, 7-11-00	17249	43.69	19.71	158	0.4
R076-89-18H5	C833-5(T-O)HO x RZM R976-89-18	18232	51.24	17.77	158	0.0
California Commercial Hybrids						
Phoenix	Spreckels, Feb. 2001	18531	52.76	17.57	164	0.0
Beta 4430R	010269FH2, 9-8-00	19768	55.32	17.84	160	0.0
HH142	Spreckels, 9-7-00	17394	49.05	17.73	148	0.0
Beta 4776R	010228FH2, 9-8-00	17921	49.73	17.99	168	0.2
Beta 4035R	rec'd 7-10-97	17371	49.13	17.66	157	0.0
US H11	1999 production, 11-3-99	13941	44.14	15.77	160	0.0
Colorado Commercial Hybrids						
Monohikari	2-16-01	17793	47.36	18.79	159	0.0
Beta 6045	2-16-01	18122	45.50	19.89	158	0.0
HM9155	2-16-01	17060	47.82	17.83	163	0.0
HM 1639	2-16-01	17044	46.86	18.18	156	0.0
Ranger	2-16-01	16969	46.86	18.14	155	0.0
Crystal 205	2-16-01	16784	46.51	17.97	158	0.0
Beta 4546	2-16-01	16671	44.54	18.72	161	0.2
USDA Experimental Hybrids						
R076-89H50	C790-15CMS x RZM R976-89R	17593	51.85	16.93	157	0.0
0941H50	C790-15CMS x RZM 9941	18270	52.25	17.46	164	0.0
0930-19H50	C790-15CMS x 8930-19 (C930-19)	17929	51.34	17.44	161	0.0
R078-9H50	C790-15CMS x R878-9	17474	49.18	17.74	156	0.4
R078H50	C790-15CMS x R978 (C78)	18823	52.00	18.09	157	0.2

TEST 2401-2801. PERFORMANCE OF COMMERCIAL HYBRIDS, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %
USDA Experimental Hybrids (cont.)						
R078H5	C833-5(T-O)HO x R978 (C78)	18192	50.54	17.97	156	0.0
R078H3	97-C562HO x R978 (C78)	16154	46.36	17.40	158	0.0
R078H2	C831-3HO x R978 (C78)	17055	48.52	17.56	153	0.0
R078H27	C831-4HO x R978 (C78)	18682	53.86	17.34	159	0.0
Mean		17542.6	49.02	17.90	158.5	0.1
LSD (.05)		947.9	2.31	0.50	6.3	0.3
C.V. (%)		7.8	6.77	3.99	5.7	715.1
F value		10.6**	14.52**	21.47**	3.2**	1.5NS

NOTES: Tests 2401 and 2801 were designed to be companion tests with 2401 to be inoculated with *Beet chlorosis virus*. The virus inoculation was not made. These two tests were then analyzed as one 24 variety x 16 replications test.

Disease pressure was very low. Field had 4 year rotation of strawberry (methyl bromide fumigation), vegetables, strawberry (methyl bromide fumigation), then sugarbeet in 2001. Thus, there did not appear to be any rhizomania, cyst nematode, or other soil borne problems. Weed pressure was very low and Nortron/ Betamix was only herbicide applied. Powdery mildew was controlled. Natural infection with *Beet western yellow virus* occurred. A very low percentage of the plants were *Curly top virus* infected. Low frequency of infection with downy mildew occurred. Frequent sprinkler irrigation was used and plants grew without known stresses.

Varieties - Colorado entries were chosen with the help of Steve Godby. Because original intent was to evaluate reaction to BChV and this virus has occurred in Colorado and California, representative hybrids from both areas were chosen. USDA entries were chosen in part based upon their expected reaction to BChV.

TEST 2501-2901. PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA, 2001

24 entries x 16 reps, RCB
1-row plots, 22 ft. long

Planted: March 23, 2001
Harvested: September 25 & 27, 2001

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100′	Bolting
		Lbs	Tons	%	No.	%
Checks						
Beta 4776R	010228FH2, 9-8-00	17066	48.09	17.74	160	0.0
Beta 6600	L9N490018AA, 7-11-00	15851	41.47	19.11	158	0.0
Phoenix	Spreckels, Feb. 2001	17523	49.83	17.59	162	0.0
HH142	Spreckels, 9-7-00	16551	46.34	17.86	149	0.0
Hybrids with S_1 pollinators						
Y068-1H50	C790-15CMS x Y868-1	15616	44.24	17.64	159	0.0
0930-19H50	C790-15CMS x 8930-19 (C930-19)	17021	49.23	17.31	161	0.0
Z025-9H50	C790-15CMS x Z825-9 (CZ25-9)	17198	46.43	18.51	155	0.0
CR009-1H50	C790-15CMS x CR909-1 (CR09-1)	16973	48.62	17.45	155	2.5
0927-29H50	C790-15CMS x 8927-29	16659	47.69	17.47	156	0.2
0929-112H50	C790-15CMS x 8929-112	17497	49.58	17.64	157	0.2
0929-114H50	C790-15CMS x 8929-114	16971	47.06	18.02	155	0.0
Hybrids with MM,S^f,Aa popns						
0931H50	C790-15CMS x RZM 9931	17305	50.94	16.98	155	0.0
0941H50	C790-15CMS x RZM 9941	17576	50.39	17.43	158	0.0
0942H50	C790-15CMS x RZM-% R576-89-18H18,19	16599	50.24	16.53	160	0.0
Z025H50	C790-15CMS x RZM Z925 (CZ25)	17151	49.03	17.51	158	0.0
CR011H50	C790-15CMS x RZM CR910,11,12	16970	49.78	17.04	155	0.0
0934H50	C790-15CMS x RZM 9934	17290	50.64	17.09	158	0.0
Hybrids with MM,OP pollinators						
Y969H50	C790-15CMS x Y869 (C69)	16874	50.54	16.69	158	0.0
R078H50	C790-15CMS x R978 (C78)	16814	48.27	17.42	156	0.0
R076-89-H50	C79-15CMS x RZM R976-89R	16284	49.08	16.58	154	0.0

TEST 2501-2901. PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
Hybrids with OP lines with *Bvm gp*						
Y067H50	C790-15CMS x RZM Y967 (C67)	16361	47.69	17.15	157	0.0
Y071H50	C790-15CMS x RZM Y971	15980	47.21	16.92	155	0.0
Y075H50	C790-15CMS x RZM-%S Y875	16011	46.51	17.23	159	0.0
R021H50	C790-15CMS x R926,7 (C26,C27)	15114	45.47	16.60	156	0.0
Mean		16718.9	48.10	17.40	156.9	0.1
LSD (.05)		851.6	2.06	0.50	5.8	0.5
C.V. (%)		7.3	6.15	4.15	5.4	604.0
F value		4.4**	9.38**	11.16**	1.7*	8.0**

NOTES: Tests 2501 & 2901 were designed to be companion tests to be inoculated with *Beet chlorosis virus*. The virus inoculation was not made. These two tests were then analyzed as one 24 variety x 16 replication test. See notes for tests 2401 and 2801.

Varieties - Varieties were chosen in part to evaluate their differential response to BChV. Except for checks, all entries had C790-15CMS as the common monogerm tester.

TEST 3101. RETEST OF S_1mmaa x C69 TOPCROSSES FROM 1999, SALINAS, 2001

12 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2001
Harvested: September 24, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %
Checks						
Beta 4430R	010269FH2, rec'd 9-8-00	17525	50.49	17.38	162	0.0
Y969H5	8833-5aa x Y869	16158	46.66	17.34	157	0.0
Retest of S_1mm lines						
Y969H5-58	8833-5-8mmaa x Y869	16762	48.47	17.29	146	0.0
Y969H5-510	8833-5-10mmaa x Y869	16560	48.47	17.10	155	0.0
Y969H5-511	8833-5-11mmaa x Y869	15636	44.68	17.50	144	0.0
Y969H5-517	8833-5-17mmaa x Y869	17054	48.37	17.63	152	0.0
Y969H5-521	8833-5-21mmaa x Y869	15751	46.26	17.04	156	0.0
Y969H35-6	8835-6mmaa x Y869	15873	47.67	16.64	147	0.0
Y969H35-17	8835-17mmaa x Y869	16199	47.36	17.11	146	0.4
Y969H35-18	8835-18mmaa x Y869	16987	52.10	16.29	155	0.0
Y969H35-24	8835-24mmaa x Y869	16098	49.48	16.26	148	0.4
Y969H35-61	8835-61mmaa x Y869	15362	45.94	16.71	145	0.0
Mean		16330.4	48.00	17.02	151.1	0.1
LSD (.05)		1190.2	3.30	0.53	9.1	0.4
C.V. (%)		7.3	6.91	3.12	6.0	661.0
F value		2.4*	3.07**	5.82**	3.2**	1.0NS

TEST 3201. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA, 2001

24 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2001
Harvested: September 24, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.
Checks					
Beta 4430R	010269FH2, rec'd 9-8-00	19107	54.72	17.47	161
Phoenix	Spreckels, rec'd March 2000	17228	49.48	17.41	161
Topcrosses to C78					
R078H50	92-790-15CMS x R978 (C78)	16526	47.97	17.24	159
R078H5	C833-5(T-O)HO x R978	16740	47.82	17.50	150
R078H3	97-562HO x R978	14706	43.27	16.98	152
R078H2	C831-3HO x R978	15680	46.03	17.04	147
R078H27	C831-4HO x R978	17424	50.89	17.13	155
R078H7	C833-5aa x R978	16446	46.36	17.74	147
R078H45	C867-1HO x R978	15772	45.85	17.19	151
R078H46	9869-6HO x R978	16553	48.12	17.20	153
R078H13	C833-12HO x R978	15444	46.51	16.61	155
R078H69	C869aa x R978	16400	48.67	16.88	153
R078H53	9833HO x R978	16273	49.25	16.50	162
R078H35	9835(T-O)aa x R978	16819	49.24	17.09	153
R078H56	9836HO x R978	15389	46.56	16.52	159
R078H19	RZM 9818aa x R978	15755	46.61	16.89	153
Retest of mm S_1 lines					
Y969H5	C833-5aa x Y869 (C69)	16535	48.22	17.15	131
Y969H5-510	8833-5-10aa x Y869	17527	50.39	17.39	152
Y969H5-511	8833-5-11aa x Y869	16373	45.85	17.86	143
Y969H5-517	8833-5-17aa x Y869	16976	48.98	17.35	152

TEST 3201. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100′
		Lbs	Tons	%	No.
Topcrosses to popn-941					
0941H50	92-790-15CMS x RZM 9941	16620	49.18	16.90	159
0941H5	C833-5(T-O)HO x RZM 9941	16640	48.57	17.13	156
0941H27	C831-4HO x RZM 9941	16872	51.60	16.36	152
0941H45	C867-1HO x RZM 9941	16242	47.43	17.13	152
Mean		16501.9	48.23	17.11	152.8
LSD (.05)		882.6	2.34	0.46	12.9
C.V. (%)		5.4	4.93	2.74	8.5
F value		7.5**	7.62	5.07**	2.1**

NOTES: C78, C69, or popn-941 were used as a topcross parent to evaluate performance of recent monogerm line developments. Except for C790-15CMS and C562HO, all monogerm lines are *Rz*_. HO = CMS. aa = genetic male sterility. C562HO = standard mm,NB,CTV,CMS inbred extensively used in California.

Test 3201 was grown without extensive disease pressure. See test 7201 for the C78 hybrids under rhizomania.

TEST 3301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS, SALINAS, 2001

48 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2001
Harvested: September 20-21, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
3301-1: Self-sterile pollinators; 16 x 8, RCB(E)						
Commercial checks						
Beta 4776R	010228FH2, 9-8-00	15979	46.51	17.16	161	0.4
Beta 4430R	010269FH2, 9-8-00	17239	49.93	17.23	159	0.0
Phoenix	February 2001	15958	47.11	16.94	161	0.0
HH142	HH142, 9-7-00	14969	44.24	16.91	147	0.0
Hybrids with FS lines						
Y067H50	92-C790-15CMS x RZM Y967, C67	14760	45.00	16.39	159	0.0
Y067-3H50	C790-15CMS x Y867-3	14022	44.29	15.82	159	0.0
Y072-4H50	x Y872-4	15633	45.60	17.14	159	0.0
R076-89-H50	x RZM R976-89R	15256	46.61	16.36	157	0.0
R976-89-18H50	x R576-89-18	14695	46.00	15.96	157	0.0
R076-89-5H50	x R876-89-5,NB	14469	43.33	16.71	149	0.4
R076-89-5-9H50	x R876-89-5NB-9	14437	41.57	17.35	153	0.0
Y068-1H50	x Y868-1	13826	40.66	16.99	161	0.0
Y068-2H50	x Y868-2	15269	47.52	16.08	164	0.0
Y068-4H50	x Y868-4	14778	43.94	16.83	159	0.0
Y068-6H50	x Y868-6	15148	44.95	16.85	159	0.0
R070-9H50	x R870-9	14933	43.84	17.04	159	0.0
Mean		15085.6	45.07	16.73	157.6	0.1
LSD (.05)		1052.8	2.51	0.62	7.6	0.4
C.V. (%)		7.1	5.62	3.72	4.8	749.0
F value		4.9**	6.51**	4.59**	2.8**	1.1NS

TEST 3301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS, 2001.
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

		Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Bolting %
Mean		15281.1	45.27	16.87	157.5	0.2
LSD (.05)		1063.6	2.56	0.60	8.6	0.5
C.V. (%)		7.1	5.73	3.62	5.6	261.5
F value		3.7**	3.41**	5.74**	1.5*	47.1**

TEST 3301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS, SALINAS, 2001

(cont.)

Variety	Description		Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolting %
3301-2: Self-sterile pollinators; 16 x 8, RCB(E)							
Hybrids with FS lines							
R078H50	92-790-15CMS	x R978,C78	15198	45.15	16.83	158	0.0
R078-3H50	C790-15CMS	x R878-3	15021	44.95	16.70	161	0.0
R078-4H50		x R878-4	15330	47.47	16.14	162	0.0
R078-8H50		x R878-8	14648	44.69	16.38	161	0.0
R078-9H50		x R878-9	14733	43.84	16.80	162	0.0
R980H50		x RZM-ER-% R780/2,C80	15015	45.35	16.54	150	0.0
R080-5H50		x R880-5	15352	46.10	16.65	158	0.0
R080-9H50		x R880-9	14648	44.24	16.56	155	0.0
R080-13H50		x R880-13	15565	44.95	17.29	153	0.0
R080/2-9H50		x R880/2-9	15831	45.00	17.60	161	0.0
R080/2-11H50		x R880/2-11	16082	46.91	17.13	160	0.0
R080-45-10H50		x R880-45-10	14622	43.84	16.67	157	0.0
Y969H50(Iso)		x RZM-ER-% Y769,C69	15889	47.36	16.77	160	0.0
Y069-13H50		x Y869-13	14994	44.95	16.69	159	0.0
Y069-18H50		x Y869-18	14012	42.89	16.31	156	0.0
Y069-26H50		x Y869-26	13732	41.97	16.34	156	0.0
Mean			15042.0	44.98	16.71	158.1	-.-
LSD (.05)			1108.3	2.52	0.64	8.3	-.-
C.V. (%)			7.4	5.66	3.88	5.3	-.-
F value			2.7**	2.77**	2.69**	1.3NS	-.-

TEST 3301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS, SALINAS, 2001
(cont.)

Variety	Description		Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %
3301-3: Population hybrids, 16 x 8, RCB(E)							
Hybrids with O.P. lines & *Bvm* gp							
Y075H50	92-790-15CMS	x RZM-% Y875	16158	47.31	17.09	159	0.0
Y071H50	C790-15CMS	x RZM Y971	15597	46.71	16.70	164	0.0
P007/8H50		x PMR-RZM P807,8-#(C)	15704	46.81	16.80	155	0.0
P007H50		x PMR-RZM P907	15780	47.11	16.75	163	0.0
P019H50		x PMR-RZM P919-#(C)	15400	45.95	16.75	159	0.0
P020H50		x PMR-RZM P920-#(C)	14704	44.49	16.52	157	8.3
R036H50		x RZM R936,(C79-8)	15084	45.55	16.55	159	0.0
R021H50	99-790-15CMS	x R926,7,(C26,C27)	14955	45.20	16.52	158	0.0
Hybrids with C833-5CMS							
R078H5	C833-5(T-O)HO	x R978,C78	16227	45.70	17.75	152	0.0
R076-89-18H5		x RZM R976-89-18,C76-89-18	16111	46.21	17.45	160	0.0
R021H5		x R926,7,(C26,C27)	15419	44.74	17.23	152	0.0
0931H5		x RZM 9931(C)	16094	46.46	17.31	152	0.0
CR009-1H5	C833-5HO	x CR909-1,CR09-1	16592	46.36	17.90	154	0.0
Z025-9H5		x Z825-9,CZ25-9	16141	43.64	18.54	157	0.0
0930-19H5		x 8930-19,C930-19	16050	45.85	17.51	154	0.0
0927-29H5		x 8927-29	15431	44.24	17.45	155	0.0
Mean			15715.6	45.77	17.18	156.8	0.5
LSD (.05)			923.7	2.64	0.44	8.0	0.8
C.V. (%)			5.9	5.82	2.57	5.1	146.7
F value			2.5*	1.29NS	13.60**	1.7NS	59.4**

NOTES: Also see tests 7301 for performance under rhizomania, B201 & B601 for performance in Imperial Valley, 101 & 401 for bolting tendency, and 4501 for reaction to *Erwinia*. From self-sterile (open-pollinated) breeding lines under going improvement, full-sib progenies were created in 1998. In 1999, these FS's were evaluated at Brawley and Salinas for combinations of disease resistance, nonbolting, and performance. Based upon these progeny tests, a few FS's were increased and crossed to a common monogerm tester in 2000. In 2001, these test cross hybrids were evaluated.

TEST 3401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS, SALINAS, CA, 2001

48 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2001
Harvested: September 19 & 20, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	Bolting %	RJAP %
3401-1: Checks & Retests, 16 x 8, RCB(E)								
Commercial checks								
Phoenix	Spreckels, February 2001	16047	45.60	17.60	164	0.3	-.-	90.2
Beta 4430R	010269FH2, 9-8-00	17412	51.23	17.02	161	0.0	-.-	87.7
HH142	Spreckels, 9-7-00	14900	43.18	17.25	151	0.4	-.-	88.2
Beta 4776R	010228FH2, 9-8-00	15796	46.56	16.96	160	0.0	-.-	89.6
Checks								
Beta 6600	L9N490018AA,7-11-00,%S check	13201	36.53	18.01	155	0.0	-.-	90.1
R078H50	F92-790-15CMS x R978, (C78)	15397	44.43	17.33	152	0.0	-.-	86.9
R078H5	9833-5(T-O)HO x R978, (C78)	15458	43.89	17.61	145	0.0	-.-	86.8
0941H5	9833-5(T-O)HO x RZM 9941	16551	47.62	17.38	149	0.0	-.-	87.0
Retests from 2000								
9924-2H50	C790-15CMS x 7924-2	15308	44.39	17.21	154	0.0	-.-	88.1
9929-45H50	x 7929-45VY	16133	47.62	16.95	155	0.0	-.-	88.6
9929-47H50	x 7929-47VY	14716	44.84	16.40	157	0.4	-.-	87.8
9929-62H50	x 7929-62VY,(C929-62)	16284	50.14	16.25	157	0.4	-.-	87.6
9930-35H50	x 7930-35VY,(C930-35)	16610	45.95	18.07	154	0.0	-.-	87.4
9927-4H50	x 7927-4VY,(C927-4)	16176	49.08	16.48	153	0.0	-.-	85.5
Sources of progeny lines								
0931H50	C790-15CMS x RZM 9931	15460	46.86	16.49	162	0.3	-.-	87.4
0747H50	x 7747	13508	44.64	15.10	157	0.0	-.-	88.2
Mean		15559.8	45.79	17.01	155.4	0.1	-.-	88.0
LSD (.05)		1120.8	2.74	0.78	8.7	0.6	-.-	0.8
C.V.(%)		7.3	6.04	4.62	5.6	503.7	-.-	1.5
F value		7.5**	11.84**	7.22**	2.5**	0.8NS	-.-	7.3**

TEST 3401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS, 2001
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

Mean		15905.0	46.06	17.27	156.4	0.1	0.3	87.5
LSD (.05)		1124.2	2.76	0.66	9.2	0.4	1.0	1.2
C.V. (%)		7.2	6.09	3.85	6.0	692.6	363.7	1.4
F value		4.7**	4.91**	8.38**	1.6**	0.9NS	10.0**	6.2**

TEST 3401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	Bolting %	RJAP %
3401-2: Sources and Self-fertile pollinators, 16 x 8, RCB(E)								
0936H50	C790-15CMS x 8936	16667	47.36	17.58	154	0.0	0.0	89.3
0942H50	x RZM-% R576-89-18H18,19	15752	47.11	16.69	161	0.0	0.0	87.0
0941H50	x RZM 9941	15606	47.11	16.54	161	0.0	0.0	88.3
Z025H50	x RZM Z925,(CZ25)	15946	45.30	17.61	149	0.4	0.0	88.5
CR011H50	x RZM CR910,11,12	15922	47.16	16.88	156	0.0	0.0	87.2
0934H50	x RZM 9934	15445	46.51	16.59	159	0.0	0.0	87.0
0926H50	x RZM-% 8926(Sp)	15647	46.31	16.89	154	0.0	0.0	87.5
P012H50	x PMR-RZM P912	14543	45.85	15.85	155	0.0	5.8	86.4
Increases of selected lines								
CR009-1H50	99-790-15CMS x CR909-1,CR09-1	16339	47.01	17.38	159	0.4	2.2	85.4
Z025-9H50	x Z825-9,CZ25-9	16062	44.69	17.96	156	0.0	0.0	87.4
0929-112H50	x 8929-112	16325	46.31	17.61	153	0.0	0.0	88.6
0929-114H50	x 8929-114	15795	44.95	17.56	159	0.0	0.0	86.8
0930-19H50	x 8930-19,C930-19	16305	47.57	17.14	156	0.0	0.0	88.2
0927-29H50	x 8927-29	15194	43.99	17.27	159	0.0	0.0	85.6
0911-4-10H50(Sp)	x 9911-4-10(C)mm,C911-4-10	15769	44.38	17.77	148	0.4	5.1	86.4
N030-5H50	C790-15CMS x RZM-NR N930-5	15107	44.19	17.10	161	0.0	0.0	86.9
Mean		15776.5	46.0	17.15	156.2	0.1	0.8	87.3
LSD (.05)		1001.1	2.4	0.56	7.2	0.5	1.8	1.1
C.V. (%)		6.4	5.3	3.30	4.6	649.0	218.0	1.2
F value		2.2NS	2.1NS	7.72**	2.3**	0.9NS	9.0**	8.3**

TEST 3401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS, SALINAS, CA, 2001
(cont.)

Variety	Description		Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100′	Root Rot	Bolting	RJAP
			Lbs	Tons	%	No.	%	%	%
3401-3: Self-fertile pollinators, 16 x 8, RCB(E)									
Selected s_1 lines									
0931-5H50	C790-15CMS	x 8931-5	15683	46.96	16.70	159	-.-	0.0	88.4
0931-7H50		x 8931-7	16209	46.71	17.34	159	-.-	0.0	86.2
0934-5H50		x 8934-5	15445	43.43	17.77	159	-.-	0.0	86.8
0935-25H50		x 8935-25	15327	45.20	16.90	157	-.-	0.0	87.9
0936-8H50		x 8936-8	15360	44.99	17.06	152	-.-	0.0	87.3
0936-10H50		x 8936-10	16645	47.36	17.60	157	-.-	0.0	87.4
0936-11H50		x 8936-11	16075	47.82	16.81	161	-.-	0.4	87.5
0936-16H50		x 8936-16	16245	44.84	18.13	165	-.-	0.0	87.5
Hybrids to C833-5CMS									
0931H5	9833-5(T-O)HO	x RZM 9931	17218	48.78	17.65	156	-.-	0.0	86.8
Z025H5		x RZM Z925,CZ25	16100	45.45	17.71	152	-.-	0.0	86.7
CR009-1H5	9833-5HO	x CR909-1,CR09-1	16614	47.16	17.61	153	-.-	0.0	86.3
Z025-9H5		x Z825-9,CZ25-9	17356	46.00	18.89	159	-.-	0.0	87.5
0929-112H5		x 8929-112	17461	47.47	18.39	155	-.-	0.0	87.9
0929-114H5		x 8929-114	17089	47.06	18.15	159	-.-	0.0	85.9
0930-19H5		x 8930-19,C930-19	16918	48.02	17.61	161	-.-	0.0	87.3
0927-29H5		x 8927-29	16314	45.45	17.95	159	-.-	0.0	86.7
Mean			16378.6	46.42	17.64	157.5	-.-	0.02	87.1
LSD (.05)			1094.1	2.76	0.60	8.7	-.-	0.27	1.3
C.V. (%)			6.8	6.00	3.45	5.6	-.-	1115.97	1.5
F value			3.3**	2.10**	7.59**	1.3NS	-.-	1.00NS	2.3**

NOTES: See test 7401 for performance under rhizomania. Test 3401 was designed to test GCA of S_1 progeny lines. From populations and early generation line and population nybrids, S_o plants were selfed to create S_1 progenies. These S_1's were evaluated at Salinas, Brawley, and Davis for various combinations of disease resistance, nonbolting tendency, and components of sugar yield, particularly sugar content. From these S_1 progeny tests, lines were selected and crossed to a common tester, C790-15CMS. These testcross hybrids were evaluated at Salinas and Brawley in 2001. Test 3401 was grown under commercial type conditions with very little known disease pressure.
9931 = popn-931. 7747 = one of first MM,S^f,A:aa random-mated populations similar to C37/C46.

TEST 7001. PERFORMANCE OF H50 EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, SALINAS, CA, 2001

24 entries x 8 reps, RCB(E)
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 11, 2001

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolting	RJAP
		Lbs	Tons	%	No.	%	%
Checks							
Beta 4776R	4-13-01	7226	20.76	17.46	182	0.0	88.1
Beta 6600	L9N490018AA, 7-11-00	4885	14.51	16.85	201	0.0	87.6
Phoenix	Spreckels, Feb. 2001	6416	18.24	17.65	157	0.0	88.7
HH142	Spreckels, 9-7-00	6349	18.73	16.99	144	0.0	85.7
Hybrids with S_1 pollinators							
Y068-1H50	C790-15CMS x Y868-1	5198	16.15	16.11	174	0.0	87.3
0930-19H50	C790-15CMS x 8930-19,(C930-19)	7775	23.01	16.88	190	0.0	87.9
Z025-9H50	C790-15CMS x Z825-9,(CZ25-9)	7462	20.38	18.30	180	0.0	87.6
CR009-1H50	C790-15CMS x CR909-1,(CR09-1)	8079	24.22	16.75	178	1.6	86.4
0927-29H50	C790-15CMS x 8927-29	6736	19.35	17.41	167	0.0	86.2
0929-112H50	C790-15CMS x 8929-112	7100	20.56	17.42	182	0.0	87.2
0929-114H50	C790-15CMS x 8929-114	6831	20.27	16.88	181	0.0	86.2
Hybrids with MM,S^f,Aa popns							
0931H50	C790-15CMS x RZM 9931	6806	20.93	16.27	197	0.0	86.8
0941H50	C790-15CMS x RZM 9941	7107	21.56	16.51	187	0.0	86.5
0942H50	C790-15CMS x RZM-% R576-89-18H18,19	6735	20.46	16.51	177	0.0	86.4
Z025H50	C790-15CMS x RZM Z925	6966	20.28	17.15	184	0.0	88.3
CR011H50	C790-15CMS x RZM CR910,11,12	7520	22.78	16.54	190	0.0	85.1
0934H50	C790-15CMS x RZM 9934	7340	22.86	16.11	187	0.0	85.8
Hybrids with MM,OP pollinators							
Y969H50	C790-15CMS x Y869,(C69)	6600	20.36	16.33	184	0.0	87.3
R078H50	C790-15CMS x R978,(C78)	6764	19.97	16.96	194	0.0	86.6
R076-89-H50	C79-15CMS x RZM R976-89R	6263	18.85	16.55	176	0.0	87.2

TEST 7001. PERFORMANCE OF H50 EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolting	RJAP
		Lbs	Tons	%	No.	%	%
Hybrids with OP lines with *Bvm gp*							
Y067H50	C790-15CMS x RZM Y967,(C67)	7875	23.46	16.79	199	0.0	87.2
Y071H50	C790-15CMS x RZM Y971	7754	23.38	16.63	168	0.0	86.1
Y075H50	C790-15CMS x RZM-%S Y875	7936	23.38	16.99	199	0.0	86.1
R021H50	C790-15CMS x R926,7,(C26,C27)	7371	22.09	16.71	186	0.0	88.2
Mean		6962.3	20.69	16.87	181.9	0.1	86.9
LSD (.05)		999.6	2.91	0.58	18.9	0.4	2.1
C.V. (%)		14.6	14.26	3.52	10.6	568.4	2.5
F value		4.8**	5.07**	6.01**	3.9**	6.0**	1.5NS

NOTES: C790-15CMS was used as a common tester for lines, populations, and progeny families selected for resistance to rhizomania and performance. C790-15CMS is susceptible to rhizomania. Beta 6600 was used as a high sugar, rhizomania susceptible check.

In addition to rhizomania, other soilborne problems occurred, e.g. sugarbeet cyst nematode, *Pythium*, *Aphanomyces*, etc. that caused high soil tare, unthrifty growth, and root pruning.

TEST 7101. RETEST OF S_1mmaa x C69 TOPCROSSES FROM 1999, SALINAS, CA, 2001

12 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 22, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Checks						
Beta 4430R	4-13-01	7997	21.28	18.89	175	90.1
Y969H5	8833-5aa x Y869	8759	24.31	18.17	187	87.7
Retest of S_1mm lines						
Y969H5-58	8833-5-8mmaa x Y869	8696	24.33	17.90	171	87.2
Y969H5-510	8833-5-10mmaa x Y869	7834	21.60	18.19	185	87.0
Y969H5-511	8833-5-11mmaa x Y869	7851	21.03	18.74	169	86.6
Y969H5-517	8833-5-17mmaa x Y869	7737	21.23	18.26	178	86.3
Y969H5-521	8833-5-21mmaa x Y869	8526	24.12	17.71	189	88.1
Y969H35-6	8835-6mmaa x Y869	8057	23.69	17.10	183	87.0
Y969H35-17	8835-17mmaa x Y869	7339	20.76	17.70	184	85.6
Y969H35-18	8835-18mmaa x Y869	6700	19.26	17.35	189	86.6
Y969H35-24	8835-24mmaa x Y869	7683	22.81	16.86	173	88.0
Y969H35-61	8835-61mmaa x Y869	7964	22.50	17.73	180	88.7
Mean		7928.5	22.24	17.88	180.4	87.4
LSD (.05)		1086.2	3.13	0.45	18.1	2.1
C.V. (%)		13.8	14.14	2.54	10.1	2.4
F value		2.2*	2.17*	14.39**	1.2NS	2.7**

TEST 7201. EVALUATION OF C78 TOPCROSS EXPERIMENTAL HYBRIDS, SALINAS, CA, 2001

12 entries x 8 reps., RCB(E)
1-row plots, 12 ft. long

Planted: May 1, 2001
Harvested: October 23, 2001

Variety	Description		Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
			Lbs	Tons	%	No.	%
Checks							
Beta 4430R	4-13-01		6440	17.68	18.25	186	88.0
Phoenix	Spreckels, rec'd March 2000		5995	16.55	18.17	173	88.3
Topcrosses to C78							
R078H50	92-790-15CMS	x R978 (C78)	7009	19.77	17.74	202	86.4
R078H5	C833-5(T-O)HO	x R978	7120	19.45	18.31	185	87.3
R078H3	97-562HO	x R978	4479	13.00	17.19	181	86.7
R078H2	C831-3HO	x R978	6335	17.62	17.99	184	86.6
R078H27	C831-4HO	x R978	8107	22.69	17.86	206	86.9
R078H7	C833-5aa	x R978	7325	19.53	18.74	172	87.6
R078H45	C867-1HO	x R978	6625	18.53	17.86	190	87.9
R078H46	9869-6HO	x R978	6598	18.84	17.50	200	88.8
R078H13	C833-12HO	x R978	6460	18.53	17.40	177	88.2
R078-9H50	C790-15CMS	x R878-9	5978	17.22	17.35	195	87.8
Mean			6539.2	18.29	17.86	187.5	87.54
LSD (.05)			1081.3	2.98	0.46	19.0	2.54
C.V. (%)			16.6	16.35	2.57	10.2	2.92
F value			5.3**	4.70**	7.95**	2.8**	0.70NS

NOTES: See test 3201. Test 7201 was grown under rhizomania conditions.

TEST 7301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001

48 entries x 8 reps, RCB(E), 3 subtests, 16x8, RCB(E)
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 24, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Bolting %	Root Rot %
Commercial checks								
Beta 4776R	4-13-01	7069	20.45	17.34	195	86.7	0.0	0.3
Beta 4430R	4-13-01	6713	18.22	18.48	176	88.4	0.0	0.3
Phoenix	Feb. 2001	6261	17.36	18.08	168	88.3	0.0	0.0
HH142	HH142, 9-7-00	5168	14.33	17.98	160	85.4	0.0	0.0
Hybrids with FS lines								
Y067H50	92-C790-15CMS x RZM Y967,C67	6930	20.13	17.21	199	87.2	0.0	0.6
Y067-3H50	C790-15CMS x Y867-3	6941	20.37	16.96	214	87.1	0.0	0.3
Y072-4H50	x Y872-4	7675	21.84	17.55	191	85.6	0.0	1.1
R076-89-H50	x RZM R976-89R	6208	18.01	17.02	191	86.2	0.0	0.9
Beta 6600	L9N49001BAA, 7-11-00, %S check	3580	10.48	17.06	201	87.3	0.0	0.0
R076-89-5H50	x R876-89-5,NB	6148	17.47	17.60	193	86.6	0.0	0.0
R076-89-5-9H50	x R876-89-5NB-9	6175	17.08	18.10	203	86.5	0.0	0.0
Y068-1H50	x Y868-1	4224	12.15	17.23	198	85.4	0.0	0.3
Y068-2H50	x Y868-2	5104	15.75	16.17	212	85.9	0.0	0.3
Y068-4H50	x Y868-4	5129	15.37	16.63	190	84.5	0.0	0.0
Y068-6H50	x Y868-6	6897	19.88	17.35	189	86.4	0.0	0.0
R070-9H50	x R870-9	6886	19.40	17.79	194	85.8	0.0	0.5
Mean		6069.4	17.39	17.41	192.2	86.5	-.-	0.3
LSD (.05)		1066.3	3.03	0.54	15.2	2.7	-.-	1.1
C.V. (%)		17.8	17.59	3.14	8.0	2.8	-.-	376.4
F value		8.8**	8.45**	9.37**	7.0**	1.5NS	-.-	0.8NS

TEST 7301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001
48 entries x 8 reps, RCB(E). ANOVA across tests to compare means.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Bolting %	Root Rot %
Mean	6401.8	18.35	17.41	192.4	86.3	0.04	0.3
LSD (.05)	1126.3	3.19	0.53	16.8	2.2	0.51	1.3
C.V. (%)	17.9	17.63	3.07	8.8	2.6	1200.70	404.6
F value	6.8**	6.45**	6.74**	2.8**	1.3NS	2.72**	1.2NS

TEST 7301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Bolting %	Root Rot %
Hybrids with FS lines								
R078H50	92-790-15CMS x R978, C78	6478	18.17	17.84	196	87.6	0.0	0.9
R078-3H50	C790-15CMS x R878-3	5857	16.82	17.31	191	86.4	0.0	0.0
R078-4H50	x R878-4	5902	17.38	17.02	199	87.4	0.0	1.1
R078-8H50	x R878-8	5760	16.86	17.05	198	87.2	0.0	0.3
R078-9H50	x R878-9	4604	13.26	17.26	190	85.7	0.0	0.3
R980H50	x RZM-ER-% R780/2,C80	5131	15.09	17.01	184	85.5	0.0	1.3
R080-5H50	x R880-5	6151	17.52	17.56	187	85.7	0.0	1.4
R080-9H50	x R880-9	5143	15.02	17.11	188	87.2	0.0	0.0
R080-13H50	x R880-13	5762	16.40	17.58	197	85.2	0.0	0.3
R080/2-9H50	x R880/2-9	6024	16.74	18.01	191	85.1	0.0	0.0
R080/2-11H50	x R880/2-11	6742	19.23	17.42	198	86.0	0.0	0.0
R080-45-10H50	x R880-45-10	6094	17.55	17.33	197	85.3	0.0	0.0
Y969H50(Iso)	x RZM-ER-% Y769,C69	5551	16.12	17.20	192	86.2	0.0	0.6
Y069-13H50	x Y869-13	6417	18.63	17.20	185	84.5	0.0	1.6
Y069-18H50	x Y869-18	5646	16.85	16.71	196	86.5	0.0	0.2
Y069-26H50	x Y869-26	5077	15.12	16.81	205	85.9	0.0	0.0
Mean		5771.3	16.67	17.28	193.3	86.1	-.-	0.5
LSD (.05)		1053.5	3.00	0.51	17.2	2.2	-.-	1.6
C.V. (%)		18.4	18.27	2.97	9.0	2.6	-.-	329.4
F value		2.3NS	1.99NS	3.67**	0.9NS	1.3NS	-.-	1.0NS

TEST 7301. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Bolting %	Root Rot %
Hybrids with O.P. lines & Bvm gp								
Y075H50	92-790-15CMS x RZM-% Y875	7870	22.52	17.50	205	86.6	0.0	0.0
Y071H50	C790-15CMS x RZM Y971	7790	22.88	17.04	199	87.5	0.0	0.0
P007/8H50	x PMR-RZM P807,8-#(C)	8774	24.54	17.89	194	86.9	0.0	0.9
P007H50	x PMR-RZM P907	7397	21.45	17.17	191	86.3	0.0	0.0
P019H50	x PMR-RZM P919-#(C)	7298	21.15	17.20	198	85.8	0.0	0.0
P020H50	x PMR-RZM P920-#(C)	6734	19.06	17.63	201	86.9	2.1	2.1
R036H50	x RZM R936, (C79-8)	6958	20.86	16.66	199	86.3	0.0	0.0
R021H50	99-790-15CMS x R926,7,(C26,C27)	6587	19.45	16.80	197	86.4	0.0	0.0
Hybrids with C833-5CMS								
R078H5	9833-5(T-O)HO x R978,C78	7233	20.15	17.84	186	86.3	0.0	0.0
R076-89-18H5	x RZM R976-89-18	6346	17.84	17.83	178	86.9	0.0	0.4
R021H5	x R926,7,(C26,C27)	7837	22.22	17.66	187	86.6	0.0	0.0
0931H5	x RZM 9931(C)	6949	19.64	17.60	187	86.1	0.0	0.0
CR009-1H5	9833-5HO x CR909-1,CR09-1	7144	20.00	17.79	189	84.3	0.0	0.0
Z025-9H5	x Z825-9, CZ25-9	7523	20.00	18.75	183	85.6	0.0	0.0
0930-19H5	x 8930-19,C930-19	8001	22.72	17.65	176	85.7	0.0	0.0
0927-29H5	x 8927-29	7396	21.06	17.55	195	86.7	0.0	0.0
Mean		7364.9	20.97	17.53	191.6	86.3	0.1	0.2
LSD (.05)		1000.2	2.75	0.51	14.6	2.0	0.9	1.2
C.V. (%)		13.7	13.26	2.94	7.7	2.3	687.9	552.1
F value		2.9NS	3.02NS	7.35**	2.6*	1.1NS	2.7**	1.9*

NOTES: Also see 3301 for performance under non-diseased conditions. See notes for test 7401. Root rot is due to *Sclerotium rolfsii*.

P007/9 is recombination of plants from two full-sib families from the backcross program to transfer powdery mildew resistance (*Pm*) from WB242 (*Bvm*) to sugarbeet that were selected for high resistance to severe rhizomania. This line shows high resistance also in Imperial Valley trials. P019 and P020 are similar to *Pm* lines released as CP01 and CP02 with powdery mildew resistance from WB97 and WB242.

TEST 7401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001

48 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 25, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Bolting %	Root Rot %
Commercial checks								
Phoenix	Feb. 2001	4700	13.12	17.74	163	86.9	0.0	1.1
Beta 4430R	4-13-01	5295	14.64	17.99	162	88.8	0.0	2.6
HH142	Spreckels, 9-7-00	6207	17.40	17.91	157	86.2	0.0	7.2
Beta 4776R	4-13-01	7314	20.57	17.84	170	87.2	0.0	3.9
Checks								
Beta 6600	L9N490018AA, 7-11-00, %S check	3586	10.28	16.92	185	86.0	0.0	1.9
R078H50	F92-790-15CMS x R978	6972	19.27	18.01	177	88.1	0.0	6.8
R078H5	9833-5(T-O)HO x R978	7443	20.31	18.08	181	86.1	0.0	3.0
0941H5	9833-5(T-O)HO x RZM 9941	6322	17.75	17.69	171	88.6	0.0	10.0
Retests from 2000								
9924-2H50	C790-15CMS x 7924-2	6634	18.49	17.85	174	88.4	0.0	4.0
9929-45H50	x 7929-45VY	6186	17.41	17.65	142	89.2	0.0	5.1
9929-47H50	x 7929-47VY	3841	11.18	16.89	158	86.0	0.0	2.3
9929-62H50	x 7929-62VY	5874	16.74	17.66	157	87.6	0.0	2.7
9930-35H50	x 7930-35VY	6578	18.12	18.26	165	87.0	0.0	5.0
9927-4H50	x 7927-4VY	6417	19.29	16.63	141	86.9	0.0	12.9
Sources of progeny lines								
0931H50	C790-15CMS x RZM 9931	6190	18.24	17.10	186	87.6	0.0	4.2
0747H50	x 7747	3739	12.28	15.25	161	86.3	0.0	6.3
Mean		5831.1	16.57	17.47	165.8	87.3	-.-	4.9
LSD (.05)		1079.6	2.97	0.78	16.7	3.1	-.-	5.9
C.V. (%)		18.7	18.08	4.51	10.2	3.6	-.-	121.0
F value		10.4**	9.45**	7.42**	5.1**	1.0NS	-.-	2.2**

TEST 7401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Bolting %	Root Rot %
Mean	6167.2	17.38	17.70	173.2	87.2	0.04	4.6
LSD (.05)	1460.9	4.07	0.72	16.8	2.9	0.38	6.0
C.V. (%)	24.1	23.77	4.07	9.9	3.4	1058.90	131.8
F value	3.4**	3.19**	3.19**	4.5**	0.9NS	1.69**	1.5NS

TEST 7401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description		Acre Yield Sugar		Sucrose	Beets/ 100'	RJAP	Bolting	Root Rot
			Lbs	Beets Tons	%	No.	%	%	%
Sources of progeny lines									
0936H50	C790-15CMS	x 8936	6240	17.89	17.42	164	86.4	0.0	4.7
0942H50		x RZM-% R576-89-18H18,19	5365	16.01	16.76	174	85.4	0.0	0.9
0941H50		x RZM 9941	5235	15.10	17.30	194	87.8	0.0	3.5
Z025H50		x RZM Z925	5527	15.82	17.42	173	87.2	0.0	7.5
CR011H50		x RZM CR910,11,12	6115	17.63	17.38	197	86.7	0.0	2.7
0934H50		x RZM 9934	6957	20.51	16.95	176	88.8	0.0	2.2
0926H50		x RZM-% 8926(Sp)	6707	19.32	17.33	173	87.3	0.0	2.6
P012H50		x PMR-RZM P912	5930	17.77	16.41	194	85.6	0.3	5.3
Increases of selected lines									
CR009-1H50	99-790-15CMS	x CR909-1	7001	19.97	17.59	186	86.2	1.2	4.6
Z025-9H50		x Z825-9	5850	15.75	18.58	182	86.9	0.0	3.0
0929-112H50		x 8929-112	5935	16.41	18.04	173	88.6	0.0	4.2
0929-114H50		x 8929-114	6109	16.91	18.11	182	87.9	0.0	3.5
0930-19H50		x 8930-19	6910	19.14	17.86	176	88.6	0.0	6.7
0927-29H50		x 8927-29	5832	15.52	18.54	176	85.6	0.0	4.5
0911-4-10H50(Sp)		x 9911-4-10(C)mm	5352	14.69	18.24	195	86.1	0.3	4.7
N030-5H50	C790-15CMS	x RZM-NR N930-5	4447	12.78	17.61	156	87.9	0.0	2.6
Mean			5969.5	16.95	17.60	179.5	87.1	0.1	4.0
LSD (.05)			1351.2	3.79	0.71	16.6	2.9	0.6	4.7
C.V. (%)			22.9	22.58	4.06	9.4	3.3	590.3	120.4
F value			2.1NS	2.41NS	5.83**	3.8**	1.2NS	1.7NS	1.0NS

TEST 7401. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description		Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Bolting	Root Rot
			Lbs	Tons	%	No.	%	%	%
Selected s_1 lines									
0931-5H50	C790-15CMS	x 8931-5	5643	16.20	17.48	174	87.8	0.0	5.8
0931-7H50		x 8931-7	6217	18.50	16.86	182	89.1	0.0	8.1
P007/8H50		x PMR-RZM P807-2,…	7750	22.35	17.39	182	87.7	0.0	7.7
0935-25H50		x 8935-25	6991	19.89	17.58	194	86.9	0.0	4.6
0936-8H50		x 8936-8	6288	17.08	18.46	159	88.3	0.0	2.5
0936-10H50		x 8936-10	7419	20.44	18.20	181	87.6	0.0	4.2
0936-11H50		x 8936-11	7037	20.66	17.20	174	87.0	0.0	2.9
0936-16H50		x 8936-16	7107	19.04	18.67	169	86.9	0.0	7.0
Hybrids to C833-5CMS									
0931H5	9833-5(T-O)HO	x RZM 9931	7432	20.53	18.06	182	87.8	0.0	3.9
Z025H5		x RZM Z925	6450	17.59	18.31	174	87.2	0.0	1.5
CR009-1H5	9833-5HO	x CR909-1	6436	18.12	17.84	174	85.7	0.0	9.9
Z025-9H5		x Z825-9	6779	17.89	18.90	184	85.7	0.0	2.2
0929-112H5		x 8929-112	6472	17.41	18.49	170	87.1	0.0	2.6
0929-114H5		x 8929-114	6341	17.50	18.13	166	87.5	0.0	5.2
0930-19H5		x 8930-19	7259	20.09	18.08	165	87.4	0.0	1.5
0927-29H5		x 8927-29	5596	14.75	18.80	158	88.2	0.0	8.9
Mean			6701.1	18.63	18.03	174.4	87.4	-.-	4.9
LSD (.05)			1403.0	3.98	0.60	14.0	2.5	-.-	7.1
C.V. (%)			21.2	21.61	3.34	8.1	2.8	-.-	147.3
F value			1.6NS	1.87NS	7.80**	3.8**	1.0NS	-.-	1.2NS

NOTES: See test 3401 for performance under non-diseased conditions and tests B301 and B501 for Imperial Valley performance; tests 101 and 401 for bolting tendency and 4501 for reaction to *Erwinia*.

Test was grown under moderate to severe rhizomania conditions and the trial was highly variable. In addition to rhizomania, other soilborne problems caused stunted plants, plant loss, and high variability. Root rot due to *Sclerotium rolfsii*.

TEST 7601. HYBRIDS OF PROGENY LINES SELECTED FOR INCREASE IN 2000, 2001, OR 2002 THAT MAY BE RELEASED, SALINAS, CA, 2001

16 entries x 6 reps, RCB
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 23, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100′ No.	Powdery Mildew 10/01	RJAP %
Checks							
Beta 4430R	Betaseed, 4-13-01	8527	23.05	18.42	169	0.0	89.3
Beta 4776R	Betaseed, 4-13-01	9483	26.29	17.97	170	0.0	89.0
HH142	Spreckels, 4-19-01	8480	24.24	17.47	161	0.4	87.9
Phoenix	Spreckels, 3-25-01	7557	21.48	17.75	169	0.0	89.3
Increased in 2000 (based upon C790-15CMS x S_1 progeny tests)							
Z025-9H50	C790-15CMS x CZ25-9	9692	26.00	18.64	185	0.0	88.0
0927-29H50	C790-15CMS x 8927-29	8712	24.06	18.13	174	0.0	87.4
0930-19H50	C790-15CMS x C930-19	9904	28.75	17.27	187	0.0	88.6
0942H50	C790-15CMS x RZM-% R576-89-18H18,19	9860	28.72	17.27	191	0.0	87.6
0929-112H50	C790-15CMS x 8929-112	10970	30.76	17.87	192	0.0	88.5
Being increased in 2001 (based upon C790-15 x S_1 progeny tests)							
9929-62H50	C790-15CMS x C929-62VY	10509	30.17	17.46	172	0.4	87.9
9930-35H50	C790-15CMS x C930-35	10736	29.35	18.36	172	0.0	88.5
9924-2H50	C790-15CMS x 7924-2	9977	27.81	17.92	169	0.0	89.6
May be increased in 2002 (based upon FS progeny test)							
Y068-1H50	C790-15CMS x Y868-2	10086	29.56	17.08	206	0.0	87.7
R078-9H50	C790-15CMS x R878-9	9088	26.20	17.35	183	0.0	89.3
R080-13H50	C790-15CMS x R880-13	10395	29.16	17.83	201	0.0	88.2
Y069-13H50	C790-15CMS x Y869-13	10951	30.56	17.97	186	0.0	88.8
Mean		9683.0	27.26	17.80	180.5	0.05	88.5
LSD (.05)		1592.7	4.44	0.50	20.7	0.39	1.5
C.V (%)		14.3	14.15	2.42	10.0	697.61	1.5
F value		3.0**	3.33**	6.67**	3.0**	0.92NS	1.6NS

NOTES: Moderate rhizomania. Released lines CZ25-9 & C930-35 combine Polish ZZ x CTR,*Rz*. Released lines C930-19 & C929-62 combine *Rz*,VYR, and high NB.

TEST 6901. WESTERN SUGAR, MICHIGAN SUGAR, HOLLY SUGAR (TORRINGTON), USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA, 2001

36 entries x 7 reps, RCB
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 15-22, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Stand Count No.	Harv. Count No.	Beets/100' No.	RJAP %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
Checks										
Beta 4776R	4-13-01 resist. ck.	7469	21.46	17.46	41	38	186	86.9	2.9	90.6
Beta 4430R	4-13-01 resist. ck.	6317	17.10	18.57	38	36	175	87.1	3.0	92.1
Beta 6600	7-11-00 susc. ck.	4134	11.97	17.38	44	40	199	86.7	4.9	22.4
Phoenix	2-5-01 resist. ck.	5471	15.18	18.07	38	34	172	87.2	3.1	88.8
HH142	4-19-01 resist. ck.	5885	16.89	17.62	37	35	168	85.9	3.2	82.0
US H11	11-3-99 susc. ck.	2599	8.86	14.83	40	35	182	88.1	4.5	31.8
Rizor	3-29-01 resist. ck.	6401	17.66	18.18	39	42	176	86.4	3.0	87.2
Monohikari	Seedex 4-16-99,susc.ck.	4346	13.13	16.33	42	34	189	88.1	4.6	29.2
Western Sugar & Holly (Torrington) entries										
Beta 4006R	4-18-01, Betaseed	3675	10.41	17.61	30	26	138	86.6	3.5	73.8
HM1639Rz	4-18-01, Hilleshog	5474	15.05	18.27	38	36	173	86.8	2.8	92.5
Beta 7CG9236LL	4-18-01, Betaseed	6591	17.32	19.11	41	39	188	86.6	3.1	89.4
HM1646Rz	4-18-01, Hilleshog	5153	13.70	18.84	38	34	171	85.0	3.2	86.1
Beta 7KJ5073	4-18-01, Betaseed	6164	16.73	18.55	43	40	195	85.3	3.2	87.2
HM 1651Rz	4-18-01, Hilleshog	5346	13.82	19.44	40	34	181	85.5	3.1	89.6
Beta 8109	4-18-01, Betaseed	3884	11.83	16.49	42	39	189	88.2	4.2	40.3
SX Kojak	4-18-01, Seedex	6140	17.67	17.39	44	43	201	86.6	3.5	71.7
Beta A940R	4-18-01, Betaseed	6084	16.30	18.68	41	38	186	86.2	3.7	65.2
Crystal 9906	4-18-01, ACH Seeds	4734	13.20	18.09	40	36	180	86.6	3.2	84.6
Beta A945R	4-18-01, Betaseed	5561	15.45	18.10	39	34	179	85.5	3.3	77.2
SX 0221	4-18-01, Seedex	6001	16.07	18.74	36	34	165	87.9	3.1	83.7
Beta BA1071	4-18-01, Betaseed	5983	15.85	18.86	39	35	176	86.3	3.5	74.6
Crystal 9941	4-18-01, ACH Seeds	6566	18.32	17.94	36	32	165	87.7	3.1	85.4

TEST 6901. WESTERN SUGAR, MICHIGAN SUGAR, HOLLY SUGAR (TORRINGTON), USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100'	RJAP	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
		Lbs	Tons	%	No.	No.	No.	%	DI	%R(0-4)
Western Sugar & Holly (Torrington) entries (cont.)										
Beta BA1073	4-18-01, Betaseed	4715	12.96	18.31	39	36	178	85.0	3.2	86.0
SX Monohikari	4-18-01, Seedex	3527	11.06	15.88	43	39	197	88.8	4.6	31.7
Crystal R181	4-18-01, ACH Seeds	4214	11.60	18.25	38	33	173	85.3	3.7	61.3
Holly (Torrington) entries (T)										
Beta 4038R	4-18-01, Betaseed	5815	15.70	18.59	39	35	177	85.8	3.0	86.3
01HX016	4-20-01, Holly Hybrids	4293	12.01	17.96	32	28	144	85.6	3.3	83.6
01HX051	4-20-01, Holly Hybrids	5963	16.04	18.61	34	32	156	85.1	3.2	83.5
01HX054	4-20-01, Holly Hybrids	5437	15.73	17.70	31	27	139	89.7	3.4	77.9
Michigan Sugar entries										
MS-RZM-1	3-27-01	2758	8.24	16.76	40	40	183	86.0	5.0	18.6
MS-RZM-2	3-27-01	6524	17.71	18.41	40	34	183	85.0	3.0	89.0
MS-E17	3-27-01, susc.check	2279	6.82	16.67	40	36	181	85.7	4.9	24.6
USDA entries										
US H11	11-3-99, susc.check	3687	12.10	15.41	42	37	190	85.0	4.7	25.7
Z025-9H5	C833-5HO x CZ25-9	6021	16.07	18.85	36	34	166	85.3	2.8	95.7
0930-19H5	C833-5HO x C930-19	6533	18.31	17.89	38	36	173	87.0	2.8	93.4
0927-29H5	C833-5HO x 8927-29	4895	12.72	19.21	40	34	182	84.6	3.1	93.6
Mean		5184.4	14.47	17.86	38.8	35.4	176.6	86.4	3.5	71.6
LSD (.05)		1442.0	4.14	0.63	4.4	5.9	20.1	1.8	0.4	11.9
C.V. (%)		26.4	27.17	3.32	10.8	15.9	10.8	1.9	9.5	15.8
F value		6.0**	4.56**	22.80**	4.3**	2.9**	4.3**	3.7**	28.2**	34.3**

NOTES: Entries were planted as two 4-rep tests separated by about 150 feet in the rhizomania test area but harvested as one test. Based upon visual appearance, seven replications were chosen for hand harvest and individual root scoring for reaction to rhizomania. After being mechanically lifted, the roots in 6901 were hand shaken to remove soil and laid out. Each individual root was scored on a scale of 0 to 9, where 9 is most severe. Based upon the reactions of hybrids such as US H11, and several known to have the Rz allele,

TEST 6901. WESTERN SUGAR, MICHIGAN SUGAR, HOLLY SUGAR (TORRINGTON), USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA, 2001
(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100'	RJAP	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
		Lbs	Tons	%	No.	No.	No.	%	DI	%R(0-4)

NOTES: (cont.): roots scored 0 to 4 were considered resistant and 5 to 9 were considered susceptible. Most resistant roots were rated as 3's and most susceptible ones as 5's to 7's. Following scoring all beets were topped and place in two sample bags. After being washed, the samples were weighed and run through the sugar lab.

Sugarbeet cyst nematodes were apparent at harvest. At emergence, an undiagnosed seedling disorder removed stand or impaired plant growth. Stands were adjusted at thinning stage. A low incidence of *Sclerotium rolfsii* occurred. Roots too severely rotted to be scored were discounted but included in the plot weight but not run through the sugar lab. Powdery mildew was controlled. Raw juice apparent purity (RJAP) was calculated. Even though 216 pounds of nitrogen per acre were applied thru the course of the season, plant appearance and high % sugars suggested that it was depleted or out of reach for these impaired root systems.

Beets per 100 feet of row were calculated from stand counts made a few weeks after thinning. Harvest count is the mean number of roots per plot scored for reaction to rhizomania. Therefore, an average of 245 roots per variety were individually scored.

Coefficients of correlations(r) were individually calculated:

	%R	HC	SY	RY	%S
Disease Index	-.98**	-.08NS	-.62**	-.54**	-.55**
% Resistant		-.08NS	.57**	.49**	.60**
Harvest Count			.10NS	.08NS	.05NS
Sugar Yield				.98**	.27**
Root Yield					.10NS

Test 6901 appeared to give a reliable comparison and evaluation of differential varietal reaction to rhizomania. Rhizomania was highly variable across the field, however, ranging from very severe to mild. Replication means for % resistant were 77,83,82,79,69,56 & 55 for 1 thru 7, respectively. This disease variability lead to higher frequencies of escapes than usual of plants rated resistant. The correlation of r = -.98 between disease index and % resistant suggested that these rating methods are very similar and probably more accurately measuring a quantitative reaction than a qualitative (frequency of *Rz* allele) reaction to rhizomania.

TEST 6801. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA, 2001

72 entries x 6 reps, RCB
1-row plots, 22 ft. long

Planted: May 1, 2001
Harvested: October 16-22, 2001

Code No.	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100'	RJAP	Rhizomania Resistance	
			Lbs	Tons	%	No.	No.	No.	%	DI	%R(0-4)
CBGA entries											
1	9J0168	Betaseed	6839	19.40	17.68	36	35	163	87.7	3.9	57.0
2	Crystal R061	Crystal	8032	23.65	17.21	32	29	145	88.4	4.1	49.6
3	7KJ0191	Betaseed	7439	21.33	17.48	38	36	173	88.1	3.3	83.2
4	SS-NB7R	Spreckels	6766	21.17	16.00	34	32	155	86.8	3.6	72.2
5	8CG7172	Betaseed	8521	26.23	16.27	40	35	183	88.9	3.1	88.7
6	99HX975	Spreckels	6545	18.32	17.94	29	27	130	85.9	3.5	71.2
7	Crystal 0024	Crystal	7769	20.97	18.48	39	38	176	88.2	4.6	34.4
8	Beta 4430R	Betaseed	8483	24.21	17.58	38	37	173	88.5	2.9	90.8
9	00HX001	Spreckels	6219	19.01	16.47	39	39	178	85.9	3.4	70.6
10	Eagle	Spreckels	6423	19.35	16.88	29	25	133	88.5	3.3	80.1
11	9GK1705	Betaseed	10134	30.64	16.62	40	40	180	89.7	2.8	96.2
12	00HX057	Spreckels	7170	21.57	16.75	26	22	116	89.4	3.4	79.5
13	Rifle	Spreckels	6111	18.22	16.99	30	28	137	88.3	3.5	74.3
14	US H11	Standard	3607	12.52	14.53	37	39	169	86.5	4.8	24.2
15	7CG7322	Betaseed	9237	27.87	16.67	34	33	154	86.8	2.8	94.7
16	99HX976	Spreckels	5337	16.80	15.88	32	29	146	85.9	3.7	65.4
17	00HX056	Spreckels	6241	18.76	16.86	31	26	139	89.8	3.6	75.2
18	8CG7166	Betaseed	9001	24.70	18.27	34	33	155	88.5	2.9	94.5
19	01HX006	Spreckels	8387	23.77	17.71	29	30	130	90.3	3.3	80.5
20	Beta 4684R	Betaseed	7617	21.87	17.44	35	30	159	86.0	3.0	87.6
21	01HX002	Spreckels	4054	11.83	17.23	31	30	142	87.2	4.1	53.3
22	Crystal 9921	Crystal	8154	25.01	16.37	39	36	178	89.5	3.1	86.7
23	00HX052	Spreckels	5204	15.77	16.67	29	29	133	89.0	3.9	58.1
24	Beta 4776R	Betaseed	8822	25.39	17.48	39	37	175	89.2	3.1	88.3
25	9J0259	Betaseed	5923	16.16	18.28	28	29	127	87.5	3.5	70.8
26	Pinnacle	Spreckels	7278	23.11	15.91	34	33	153	87.8	3.5	69.8
27	Rodeo	Spreckels	4022	11.79	17.09	28	26	127	87.4	3.7	69.8

TEST 6801. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA, 2001

(cont.)

Code No.	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100'	RJAP	Rhizomania Resistance	
			Lbs	Tons	%	No.	No.	No.	%	DI	%R(0-4)
CBGA entries (cont.)											
28	Phoenix	Spreckels	7031	20.02	17.77	30	26	135	88.5	3.6	70.5
29	01HX008	Spreckels	8481	24.19	17.64	37	36	169	87.3	3.0	89.5
30	99HX981	Spreckels	3738	11.86	15.73	12	12	53	88.1	3.4	82.2
31	7KJ0146	Betaseed	7055	19.73	18.06	35	31	158	87.5	3.4	77.0
32	00HX010	Spreckels	7236	22.99	15.85	25	23	114	88.4	3.7	66.2
33	99HX979	Spreckels	8266	24.65	16.84	31	31	142	88.5	2.6	96.7
34	8CG7165	Betaseed	6781	20.51	16.56	31	28	139	87.8	2.9	95.6
35	00HX054	Spreckels	7786	23.69	16.72	28	26	125	88.5	3.4	78.8
36	Beta 4035R	Betaseed	7603	22.33	17.12	37	36	169	87.2	3.0	88.3
37	HH-143	Spreckels	6514	19.43	16.77	38	34	172	87.6	4.3	45.7
38	9GK1701	Betaseed	9376	29.03	16.31	38	39	170	88.2	2.9	92.9
39	00HX053	Spreckels	7575	23.13	16.53	27	24	123	88.5	3.4	80.8
40	8CG7168	Betaseed	8174	25.28	16.18	38	38	170	89.1	2.7	96.8
41	01HX004	Spreckels	4436	13.70	16.16	26	21	120	88.3	3.5	75.6
42	01HX005	Spreckels	3762	11.77	16.07	20	11	89	86.6	3.3	88.3
43	4KJ0164	Betaseed	8701	28.83	15.13	39	38	179	88.1	3.0	84.7
44	00HX055	Spreckels	6721	18.83	17.72	36	34	161	89.1	3.3	82.2
45	00HX051	Spreckels	5646	16.10	17.56	27	27	121	89.6	3.4	79.2
46	01HX012	Spreckels	7145	22.59	15.88	38	35	173	87.5	3.4	74.2
47	9GK7003	Betaseed	9670	30.01	16.30	34	32	155	87.7	2.8	97.0
48	01HX003	Spreckels	5041	14.60	17.54	22	22	102	87.2	3.7	68.7
49	HH-144	Spreckels	5852	17.96	16.39	37	35	170	88.4	4.6	32.8
50	7CG7410	Betaseed	7122	21.78	16.52	38	37	170	87.1	4.0	56.0
51	Crystal 0025	Crystal	8308	24.32	17.15	31	31	142	88.2	3.7	56.2

TEST 6801. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA, 2001

(cont.)

Code No.	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Stand Count No.	Harv. Count No.	Beets/ 100' No.	RJAP %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
CBGA entries (cont.)											
52	01HX007	Spreckels	1910	5.41	17.43	18	11	80	84.6	3.8	63.4
53	Beta 4210R	Betaseed	8222	23.68	17.36	35	33	161	88.5	3.0	90.6
54	Crystal 9923	Crystal	6474	18.35	17.58	34	32	156	88.7	3.9	56.5
55	Crystal 9922	Crystal	7555	22.84	16.63	35	33	158	89.1	3.9	56.6
56	9GK7014	Betaseed	9526	28.14	16.95	38	37	170	88.8	2.7	96.9
57	HH-141	Spreckels	5293	15.42	17.43	34	29	155	86.5	3.2	87.2
58	99HX986	Spreckels	6544	19.71	16.58	36	34	161	86.0	3.2	81.6
59	Beta 4300R	Betaseed	7961	22.35	17.85	43	40	193	87.9	3.4	75.8
60	Crystal R062	Crystal	7341	19.97	18.57	35	34	157	89.1	3.2	80.4
61	01HX001	Spreckels	7159	22.49	16.11	34	29	152	89.3	3.2	86.5
62	8CG7167	Betaseed	7153	22.56	15.88	36	37	164	88.7	3.1	89.0
63	01HX010	Spreckels	10081	30.29	16.84	39	37	176	88.2	3.1	89.5
64	Alpine	Spreckels	6339	19.60	16.33	32	31	147	85.0	3.4	75.4
65	Beta 4175R	Betaseed	8770	27.51	16.00	37	36	168	88.5	2.9	93.0
66	01HX011	Spreckels	7946	23.48	16.98	34	34	155	86.4	3.4	75.4
67	HH-142	Spreckels	7162	21.29	17.05	32	30	146	86.7	3.5	72.2
68	9GK1596	Betaseed	6042	17.25	17.55	32	31	145	87.1	3.0	93.3
69	8CG7164	Betaseed	10006	28.40	17.75	39	39	175	87.7	2.6	98.3
USDA entries											
70	R078H5	C833-5CMS x C78	8226	23.51	17.58	35	38	159	85.6	3.0	89.3
71	0930-19H5	C833-5CMS x C930-19	8942	25.86	17.37	39	37	176	87.8	2.9	92.0
72	US H11	Susc. check	2823	9.26	15.10	42	37	192	87.1	5.1	14.8
Mean			7067.1	21.93	16.89	33.3	31.4	151.3	87.9	3.4	76.1
LSD (.05)			1778.2	5.58	0.80	6.6	5.4	30.1	2.2	0.4	14.4
C.V. (%)			22.2	23.35	4.16	17.5	15.1	17.5	2.2	10.5	16.7
F value			7.4**	6.65**	8.04**	5.7**	10.6**	5.7**	2.2**	12.0**	11.8**

TEST 6801. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA, 2001

(cont.)

Code No.	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100'	RJAP	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
			Lbs	Tons	%	No.	No.	No.	%	DI	%R(0-4)

NOTES: Entries were planted as two 4 rep. Tests separated by about 150 ft. in the rhizomania test area. Based upon visual appearance, the six most uniform reps were chosen for hand harvest and individual root scoring for reaction to rhizomania. After being mechanically lifted, the roots were hand shaken to remove soil and laid out. Each individual root was scored on a scale of 0 to 9 where 9 is most severe. Based upon the reactions of US H11 and several resistant hybrids known to have the Rz allele, roots that scored 0 to 4 were considered resistant and 5 to 9 were considered susceptible. Most resistant roots were rated as 3's and most susceptible ones in the 5 to 7 range. Following scoring all beets were topped and place in two sample bags. After being washed, the samples were weighed and run through the sugar lab.

A very low incidence of *Sclerotium rolfsii* occurred. Roots too severely rotted to be scored were discounted but included in the plot weight but not run through the sugar lab. Powdery mildew was controlled. Raw juice apparent purity (RJAP) was calculated from (% sucrose/% soluble solids)100.

Coefficients of correlations were calculated for 6801:

	%R	HC	SY	RY	%S
Disease Index	-.97**	-.13**	-.55**	-.53**	-.06NS
% Resistant		.04NS	.49**	.47**	.05NS
Harvest Count			.40**	.36**	.08NS
Sugar Yield				.98**	-.05NS
Root Yield					-.23**

Beets per 100 feet of row were calculated from stand counts made post thinning. Harvest count is the mean number of roots per plot scored for reaction to rhizomania.

Although the field was more variable than usual for severity of rhizomania, expression of symptoms, and other soilborne problems, test 6801 appeared to give a reliable comparison and evaluation of differential host-plant (variety) reaction to rhizomania.

TEST B101. EVALUATION OF EXPERIMENTAL HYBRIDS, IMPERIAL VALLEY, 2000-2001

24 entries x 8 reps., RCB(E)
1-row plots, 18 ft. long

Planted: September 13, 2000
Harvested: May 14, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Checks								
Beta 4430R	010269FH2, rec'd 9-8-00	13524	41.29	16.34	199	0.0	90.7	109
Phoenix	Spreckels, rec'd March 2000	11286	35.87	15.72	200	0.3	92.2	118
Topcrosses to C78								
R078H50	92-790-15CMS x R978(C78)	10277	32.79	15.69	195	1.8	90.4	104
R078H5	9833-5(T-O)HO x R978	11475	35.54	16.27	184	0.3	98.1	86
R078H3	97-562HO x R978	7994	26.63	15.03	188	0.7	91.7	115
R078H2	C831-3HO x R978	9060	28.59	15.84	190	1.5	90.5	83
R078H27	C831-4HO x R978	10122	33.92	14.93	186	1.5	92.3	134
R078H37	4807HO (C306/2HO) x R978	9370	31.17	15.02	179	0.0	91.4	146
R078H45	C867-1HO x R978	9632	31.18	15.43	190	5.3	89.5	93
R078H46	9869-6HO x R978	9415	30.04	15.68	168	2.9	90.1	82
R078H13	C833-12HO x R978	10114	31.82	15.84	190	0.0	91.7	102
R078H69	C869aa x R978	9892	31.73	15.56	189	1.9	92.4	112
R078H53	9833HO x R978	10363	32.63	15.84	190	2.4	92.7	91
R078H35	9835(T-O)aa x R978	10375	33.29	15.53	194	0.8	90.9	124
R078H56	9836HO x R978	9527	31.06	15.34	193	1.9	89.8	86
R078H19	RZM 9818aa x R978	10052	31.30	16.07	197	0.3	90.0	80
Retest of mm S_1 lines								
Y969H5	C833-5aa x Y869	10445	33.04	15.85	177	0.0	89.4	80
Y969H5-510	8833-5-10aa x Y869	11637	37.48	15.54	179	0.4	92.4	107
Y969H5-511	8833-5-11aa x Y869	9603	29.37	16.38	177	0.0	91.4	64
Y969H5-517	8833-5-17aa x Y869	10245	33.52	15.23	190	0.0	91.4	124

TEST B101. EVALUATION OF EXPERIMENTAL HYBRIDS, IMPERIAL VALLEY, 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Topcrosses to popn-941								
0941H50	92-790-15CMS x RZM 9941	10467	34.78	15.02	188	0.4	90.8	99
0941H5	9833-5(T-O)HO x RZM 9941	10027	31.53	15.87	183	0.4	89.7	74
0941H27	C831-4HO x RZM 9941	11072	37.75	14.63	168	0.0	92.8	77
0941H45	C867-1HO x RZM 9941	9933	33.50	14.88	177	5.4	92.3	101
Mean		10246.0	32.91	15.56	186.2	1.2	91.4	99.6
LSD (.05)		1661.0	4.80	1.06	21.2	2.1	5.1	62.2
C.V. (%)		16.4	14.76	6.87	11.5	181.1	5.7	63.3
F value		3.2**	3.41**	1.60*	1.3NS	4.2**	0.9NS	0.9NS

Test B101 was designed to evaluate topcross hybrids. C78 was used as the common tester with different monogerm breeding and progeny lines.

92-790-15CMS = C790-15CMS = C790-68CMS x C790-15. C833-5CMS = 9833-5(T-O)HO. C833-5 = 8833-5. C562HO = C562CMS = NB,CTR monogerm inbred that was formerly widely used in commercial hybrids (USH9, USH10, USH11). C306 is a monogerm line with resistance to LIYV (did not occur in this test). C869, 9833, 9835, 9836, and 9818 = mm,S^f,Aa,*Rz* random-mated populations.

TEST B201. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS, IMPERIAL VALLEY, 2000-2001

48 entries x 8 reps., RCB(E)
1-row plots, 18 ft. long

Planted: September 13, 2000
Harvested: May 14 & 15, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Commercial Checks								
Beta 4776R	010228FH2, rec'd 9-8-00	10214	30.57	16.66	179	0.0	95.3	121
Beta 4430R	010269FH2, rec'd 9-8-00	12270	36.61	16.72	169	0.0	95.8	93
Phoenix	Spreckels, rec'd March 2000	10950	33.72	16.23	180	0.0	97.6	141
HH142	HH142, rec'd 9-7-00	9682	30.60	15.86	180	0.4	97.2	119
Hybrids with FS lines								
Y067H50	92-C790-15CMS x RZM Y967(C67)	10311	31.86	16.11	181	0.0	94.5	108
Y067-3H50	C790-15CMS x Y867-3	11530	34.81	16.54	188	2.2	95.3	65
Y072-4H50	x Y872-4	11042	33.85	16.32	170	0.0	93.8	66
R076-89H50	x RZM R976-89R	10974	35.08	15.74	181	3.7	96.0	106
R976-89-18H50	x C76-89-18	11620	36.29	15.99	169	1.6	95.7	53
R076-89-5H50	x C76-89-5,NB	10345	31.14	16.59	187	0.0	95.7	64
R076-89-5-9H50	x R876-89-5NB-9	8932	26.85	16.57	169	0.0	94.3	73
Y068-1H50	x Y868-1	10030	30.60	16.44	171	0.0	93.3	62
Y068-2H50	x Y868-2	10681	32.37	16.50	178	0.0	91.2	31
Y068-4H50	x Y868-4	10433	32.08	16.23	174	0.8	93.8	80
Y068-6H50	x Y868-6	9914	31.64	15.64	179	3.7	96.6	98
R070-9H50	x R870-9	10901	34.84	15.65	177	4.1	94.8	119
Hybrids with FS lines								
R078H50	92-790-15CMS x R978 (C78)	10807	32.70	16.54	174	2.9	92.6	59
R078-3H50	C790-15CMS x R878-3	11829	35.84	16.48	163	0.5	96.1	67
R078-4H50	x R878-4	12362	37.34	16.57	178	0.0	94.5	40
R078-8H50	x R878-8	11136	33.74	16.51	179	0.0	96.5	63
R078-9H50	x R878-9	10970	33.16	16.56	185	0.0	94.2	49
R980H50	x RZM-ER-% R780/2	11135	32.61	17.05	179	0.0	95.5	32
R080-5H50	x R880-5	10603	31.20	17.01	182	1.5	93.8	37
R080-9H50	x R880-9	10907	32.99	16.55	174	0.0	91.8	60
R080-13H50	C790-15CMS x R880-13	10682	31.55	16.91	173	0.0	92.9	43
R080/2-9H50	x R880/2-9	10537	30.63	17.19	185	0.3	93.5	31

TEST B201. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS, IMPERIAL VALLEY, 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Hybrids with FS lines (cont.)								
R080/2-11H50	C790-15CMSx R880/2-11	10662	31.71	16.83	174	0.4	94.3	25
R080-45-10H50	x R880-45-10	11905	35.19	16.94	179	0.0	95.5	41
Y969H50(Iso)	x RZM-ER-%Y769(C69)	11889	35.68	16.67	176	0.4	94.9	64
Y069-13H50	x Y869-13	10389	30.89	16.82	177	0.0	93.6	54
Y069-18H50	x Y869-18	11119	33.37	16.68	179	0.0	96.3	57
Y069-26H50	x Y869-26	10639	31.08	17.13	169	1.2	95.2	47
Y075H50	92-790-15CMS x RZM-% Y875	11983	36.30	16.52	181	0.0	94.0	69
Y071H50	C790-15CMS x RZM Y971	11054	33.57	16.49	169	0.0	94.2	52
P007/8H50	x PMR-RZM P807,8-#(C)	11490	33.57	17.11	181	0.0	94.2	24
P007H50	x PMR-RZM P907	10455	31.07	16.83	179	4.9	94.0	47
P019H50	x PMR-RZM P919-#(C)	11599	35.11	16.55	168	3.3	94.2	72
P020H50	x PMR-RZM P920-#(C)	11977	37.01	16.20	177	4.3	94.6	52
R036H50	x RZM R936 (C790-8)	11423	34.78	16.43	188	2.9	94.5	51
R021H50	99-790-15CMSxR926,7(C26,C27)	10081	30.46	16.56	181	7.6	93.0	54
Hybrids with C833-5CMS								
R078H5	9833-5(T-O)HO x R978(C78)	10934	31.15	17.56	180	1.1	94.9	34
R076-89-18H5	x RZM R976-89-18	11171	32.43	17.23	173	0.0	96.8	31
R021H5	x R926,7(C26,C27)	10192	30.22	16.88	182	5.1	93.0	50
0931H5	x RZM 9931(C)	10700	31.41	17.06	185	0.8	94.2	34
CR009-1H5	9833-5HO x CR909-1(CR09-1)	11071	32.95	16.82	189	0.0	93.4	47
Z025-9H5	x Z825-9(CZ25-9)	10004	28.32	17.66	179	0.0	93.1	35
0930-19H5	x 8930-19	11471	33.84	16.96	174	0.0	95.7	30
0927-29H5	x 8927-29	8486	25.65	16.56	172	0.0	95.1	44
Mean		10864.4	32.72	16.62	177.4	1.1	94.6	60.2
LSD (.05)		1094.5	2.92	0.76	17.2	2.0	2.2	51.3
C.V. (%)		10.2	9.05	4.64	9.9	184.6	2.3	86.5
F value		4.0**	5.67**	2.55**	0.9NS	6.1**	3.1**	2.3**

See notes for B601 and B301.

TEST B301. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS, IMPERIAL VALLEY, CA., 2000-2001

48 entries x 8 reps., RCB(E)
1-row plots, 18 ft. long

Planted: September 13, 2000
Harvested: May 16, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Commercial Checks								
HH142	HH142, rec'd 9-7-00	10411	31.74	16.38	166	0.0	98.3	104
Phoenix	Spreckels, rec'd March 2000	10567	31.14	16.94	186	0.0	98.2	135
Beta 4430R	010269FH2, rec'd 9-8-00	12693	37.07	17.06	193	0.0	97.2	115
Beta 4776R	010228FH2, rec'd 9-8-00	10013	29.56	16.95	186	0.0	97.3	120
Checks								
R078H50	F92-790-15CMS x R978(C78)	10600	32.36	16.39	187	3.1	95.9	153
R078H5	9833-5(T-O)HO x R978(C78)	10887	32.12	16.98	176	3.7	95.6	84
0941H5	9833-5(T-O)HO x RZM 9941	9872	29.60	16.71	170	0.0	96.0	84
Retests from 2000								
9924-6H50	C790-15CMS x 7924-6	10384	31.03	16.74	182	0.0	92.0	64
9929-45H50	x 7929-45VY	12038	35.51	16.99	170	2.0	96.3	78
9929-47H50	x 7929-47VY	10336	31.40	16.47	183	1.8	95.8	90
9929-62H50	x 7929-62VY	11772	35.98	16.43	182	0.0	96.8	119
9930-35H50	x 7930-35VY	10498	29.80	17.60	183	0.9	96.0	82
9931-29H50	x 7931-29	11517	34.71	16.60	169	2.1	95.5	69
9927-4H50	x 7927-4VY	11300	35.15	16.02	188	0.7	96.1	137
Sources								
0931H50	x RZM 9931	10786	33.10	16.31	166	2.8	94.1	101
0747H50	x 7747	8869	28.70	15.47	186	0.0	94.1	80
0936H50	C790-15CMS x 8936	11098	33.05	16.82	169	0.4	95.3	69
0942H50	x RZM-% R576-89-18H18	11277	33.58	16.77	170	0.0	95.5	46
0941H50	C790-15CMS x RZM 9941	10842	32.50	16.66	185	1.5	96.1	66
Z025H50	x RZM Z925	11251	33.76	16.68	181	2.4	95.7	63

TEST B301. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Sources (cont.)								
CR011H50	x RZM CR910,11,12	11020	33.83	16.28	179	4.8	94.9	112
0934H50	x RZM 9934	10383	32.90	15.83	186	0.3	96.4	101
0926H50	x RZM-% 8926(Sp)	11157	33.71	16.58	176	0.0	94.0	105
P012H50	x PMR-RZM P912	11902	35.51	16.80	178	18.0	95.1	60
Increases of selected lines								
CR009-1H50	99-790-15CMS x CR909-1(CR09-1)	11214	34.04	16.48	172	1.7	95.5	73
Z025-9H50	x Z825-9(CZ25-9)	10208	29.39	17.40	208	0.4	96.0	93
0929-112H50	x 8929-112	9963	28.53	17.46	172	1.8	96.8	55
0929-114H50	x 8929-114	10543	31.25	16.86	181	1.1	95.5	50
0930-19H50	x 8930-19	11482	33.25	17.33	176	0.0	96.9	77
0927-29H50	x 8927-29	9721	29.67	16.45	193	0.4	96.4	84
0911-4-10H50(Sp)	x 9911-4-10(C)mm	8910	25.86	17.20	173	3.1	94.7	31
N030-5H50	C790-15CMS x RZM-NR N930-5	9778	29.60	16.51	183	0.4	95.0	65
Selected S_1 lines								
0931-5H50	C790-15CMS x 8931-5	11249	34.15	16.50	190	0.0	94.4	67
0931-7H50	x 8931-7	10103	30.34	16.71	177	0.4	94.9	37
0934-5H50	x 8934-5	10843	31.49	17.19	170	0.5	94.3	37
0935-25H50	x 8935-25	9827	29.53	16.68	166	0.0	95.5	63
0936-8H50	x 8936-8	9195	26.79	17.12	182	0.0	95.0	32
0936-10H50	x 8936-10	11639	34.17	17.06	186	0.4	96.7	57
0936-11H50	x 8936-11	10837	32.21	16.86	183	0.0	97.7	43
0936-16H50	x 8936-16	8565	24.91	17.19	184	0.0	95.7	32
Hybrids to C833-5CMS								
0931H5	9833-5(T-O)HO x RZM 9931	11442	34.04	16.80	181	1.4	96.4	91
Z025H5	9833-5(T-0)HO x RZM Z925	11205	32.41	17.27	174	0.7	96.9	48
CR009-1H5	9833-5HO x CR909-1	10567	31.42	16.82	162	0.4	96.4	60
Z025-9H5	x Z825-9	10001	27.83	17.94	186	0.0	94.7	62
0929-112H5	x 8929-112	10538	29.89	17.64	180	1.2	96.1	40
0929-114H5	x 8929-114	10922	31.66	17.26	190	0.4	94.7	37

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Hybrids to C833-5CMS (cont.)								
0930-19H5	x 8930-19	11767	34.74	16.93	183	0.0	95.7	48
0927-29H5	x 8927-29	8626	25.51	16.89	170	0.0	95.4	51
Mean		10637.8	31.68	16.81	179.5	1.2	95.7	74.3
LSD (.05)		1122.5	3.21	0.70	18.9	2.1	1.6	26.4
C.V. (%)		10.7	10.28	4.24	10.7	175.5	1.7	36.0
F value		5.0**	5.93	3.35**	1.7**	12.8**	3.8**	10.1**

See Test B501 for same entries under rhizomania. After harvest in 2001 at Salinas, see Tests 101, 201, 301 & 401 for bolting evaluation; 4301 & 4501 for *Erwinia* and powdery mildew evaluation; 2201 & 3401 for yield performance; and 6201 & 7401 for performance under rhizomania. Test B301 was grown under fairly low nitrogen status. Powdery mildew was not controlled. There may have been a low level of rhizomania. Otherwise test appeared to be very good.

S_1 progeny pollinators: Multigerm, self-fertile, genetic-male-sterile facilitated random-mated populations have been developed and improved. From these, individual *Aa* plants were selfed to produce S_1 progeny. These S_1 progeny were evaluated in S_1 progeny tests at Salinas under bolting, yield, and rhizomania conditions and sometimes at Brawley and Davis. On the basis of these tests, S_1 progeny were selected, increased, and crossed to a common mmCMS tester. This is a test of these testcross hybrids. On the basis of these tests a few lines will be advanced and possibly released to the seed industry.

NOTES: 7929-62VY will likely be released in 2001 as C929-62. 7930-35VY as C930-35. 7927-4VY as C927-4. VY signifies that these S_1 progeny lines were selected in part on the basis of their performance under virus yellows at Davis, CA in cooperation with Dr. S.R. Kaffka. In addition, 7927-4VY has very high resistance to rhizomania derived from C51 (aka R22) (see tests B1001 & B1101). Line 8930-19 may also be released as C930-19. 8930-19 has very high nonbolting tendency with moderate resistance to curly top virus.

9833-5(T-O)HO & 9833-5HO = C833-5CMS. C790-15CMS(F92-790-15CMS) = C790-68CMS x C790-15. 9931 = MM,S^f,Aa,Rz popn-931. 7747 = MM,S^f,Aa,popn-747, the rhizomania susc. base of popn-931, that is similar to C37. Z925 = MM,S^f,Aa,Rz popn-Z25 that is similar to CZ25 and has about 1/3 Polish ZZ germplasm. CR910,11,12 = MM,S^f,Aa,Rz popn-CR11 that has resistance to cercospora leaf spot from Italian germplasm. 8926 = MM,S^f,Aa,Rz popn-926 that has resistance to rhizomania from C51 (R22) with *Bvm* germplasm. P912 = population with powdery mildew resistance from WB97 & 242.

TEST B401. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY,CA., 2000-2001

27 entries x 8 reps, RCB
2-row plots, 18 ft. long

Planted: September 13, 2000
Harvested: June 4, 2001

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean	Powdery Mildew 3/29	Powdery Mildew 5/15	Powdery Mildew Mean
001VMH- 1	7KJ0191	Betaseed	11067	31.93	17.31	170	0.2	96.1	117	6.3	7.8	7.0
- 2	Beta 4684R	Betaseed	10860	32.73	16.64	182	0.0	97.5	147	4.8	5.6	5.2
- 3	99HX975	Spreckels	11542	33.42	17.26	153	0.2	96.4	91	3.5	6.6	5.1
- 4	00HX053	Spreckels	11788	32.97	17.89	171	0.8	97.3	74	2.0	4.4	3.2
- 5	Beta 4035R	Betaseed	11516	35.26	16.32	175	0.6	96.7	127	5.6	6.8	6.2
- 6	9GK7014	Betaseed	12952	37.71	17.19	179	0.2	95.5	108	1.5	5.0	3.3
- 7	00HX054	Spreckels	11892	34.83	17.10	173	0.2	96.8	101	1.3	4.1	2.7
- 8	7CG7322	Betaseed	11764	35.80	16.48	170	0.0	96.4	137	3.5	5.6	4.6
- 9	00HX010	Spreckels	11395	36.24	15.72	181	0.0	97.8	167	3.5	5.8	4.6
-10	Beta 4430R	Betaseed	13491	39.08	17.26	178	0.0	96.7	77	1.8	4.5	3.1
-11	99HX979	Spreckels	9681	28.91	16.77	178	0.0	96.8	103	4.5	6.9	5.7
-12	8CG7164	Betaseed	13550	38.90	17.40	183	0.7	96.3	107	1.1	5.0	3.1
-13	9GK7003	Betaseed	13986	42.37	16.54	183	0.0	96.6	121	2.1	4.6	3.4
-14	Phoenix	Spreckels	11972	36.64	16.36	179	0.2	97.9	147	4.8	6.6	5.7
-15	US H11	Standard	8359	27.98	14.94	180	0.2	94.5	102	6.3	5.0	5.6
-16	00HX055	Spreckels	11770	33.39	17.63	189	0.0	96.4	70	2.9	5.5	4.2
-17	Eagle	Spreckels	12287	37.37	16.46	176	0.0	98.0	127	4.0	6.8	5.4
-18	HH-142	Spreckels	11199	33.62	16.66	170	0.7	97.5	98	1.8	4.3	3.0
-19	99HX981	Spreckels	10101	33.23	15.25	158	0.0	97.3	148	7.9	7.5	7.7
-20	HH-141	Spreckels	11620	35.27	16.52	181	0.0	97.2	92	2.4	6.1	4.3
-21	8CG7172	Betaseed	12694	38.63	16.47	184	0.0	95.6	155	7.9	7.6	7.8

TEST B401. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY,CA., 2000-2001

(cont.)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean	Powdery Mildew 3/29	Powdery Mildew 5/15	Powdery Mildew Mean
OO1VMH-22	Pinnacle	Spreckels	10557	32.60	16.18	172	2.4	97.5	100	5.5	7.6	6.6
-23	B4776R	Betaseed	10687	30.88	17.31	183	0.0	96.7	94	4.0	5.4	4.7
-24	8CG7165	Betaseed	12272	38.49	15.94	179	0.0	96.5	129	8.0	7.5	7.8
-25	9GK1596	Betaseed	13156	37.79	17.43	177	0.0	97.2	94	2.9	4.5	3.7
USDA fillers												
-26	Z025-9H5	USDA	10446	29.33	17.84	180	0.0	96.3	66	1.6	4.1	2.9
-27	Z025-9H50	USDA	9966	28.03	17.82	173	0.0	95.6	66	1.4	3.9	2.6
Mean			11576.6	34.57	16.77	176.2	0.2	96.7	109.8	3.8	5.7	4.8
LSD (.05)			958.7	2.89	0.73	14.5	0.7	1.2	59.4	1.2	0.7	0.6
C.V. (%)			8.4	8.46	4.44	8.3	316.9	1.3	54.8	30.7	11.6	13.5
F value			14.1**	12.63**	8.34**	2.3**	3.5**	3.6**	1.8*	27.1**	28.7**	51.6**

NOTES: Powdery mildew not controlled. Test appeared good but low in fertility at harvest. Except for mildew, no other significant foliar problems observed. May have had low level of rhizomania.

Powdery mildew scored on a scale of 0 to 9, where 9 is most severe and each increment represents about a 10% increase in leaf area affected by mildew. PM score 3/29/01 by Dr. J. Gerik and 5/15/01 by Dr. R. Lewellen. As is often observed with powdery mildew infection, the greatest differences are with initial infection (differences in slow-mildewing) with apparent reactions evening out as the season progresses.

TEST B401. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY,CA., 2000-2001

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
OO1VMH- 1	7KJ0191	10148	317	91.6	919	414	2007	333	9632
- 2	Beta 4684R	9832	302	90.5	1027	352	2014	431	10357
- 3	99HX975	10539	315	91.2	1003	367	2015	386	9993
- 4	00HX053	10901	331	92.5	887	344	1827	332	8926
- 5	Beta 4035R	10510	298	91.2	1006	412	1938	341	9530
- 6	9GK7014	11981	318	92.5	971	358	1819	294	8594
- 7	00HX054	10972	315	92.2	920	398	1812	308	8846
- 8	7CG7322	10641	298	90.4	1123	465	2036	388	10403
- 9	00HX010	10421	288	91.4	974	375	1775	332	8902
-10	Beta 4430R	12551	321	93.0	939	419	1620	262	8004
-11	99HX979	8902	308	91.9	779	382	1704	360	9021
-12	8CG7164	12510	321	92.3	1040	385	1830	316	8923
-13	9GK7003	12738	301	91.1	1248	453	2017	332	9784
-14	Phoenix	10986	300	91.7	986	407	1751	333	8963
-15	US H11	7484	268	89.6	875	409	2012	403	10294
-16	00HX055	10910	327	92.7	859	387	1750	300	8581
-17	Eagle	11245	301	91.6	1042	437	2086	265	9263
-18	HH-142	10148	302	90.6	1051	372	2252	368	10430
-19	99HX981	9086	275	89.9	1015	483	2125	325	10090
-20	HH-141	10601	302	91.2	1019	358	1959	365	9615
-21	8CG7172	11596	301	91.3	1098	349	2059	324	9445

TEST B401. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY,CA., 2000-2001

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
OO1VMH-22	Pinnacle	9614	295	91.0	943	406	2106	318	9709
-23	B4776R	9829	319	92.0	858	362	1779	372	9252
-24	8CG7165	11217	292	91.4	1055	357	2000	300	9104
-25	9GK1596	12150	322	92.4	1006	322	1989	290	8857
USDA fillers									
-26	Z025-9H5	9540	326	91.4	905	319	1786	491	10248
-27	Z025-9H50	9157	328	92.0	809	260	1883	410	9514
Mean		10600.3	307.1	91.5	976.2	383.5	1924.2	343.7	9417.9
LSD (.05)		910.2	16.7	1.6	181.6	125.0	286.3	79.7	1453.1
C.V. (%)		8.7	5.5	1.7	18.9	33.0	15.1	23.5	15.6
F value		14.2**	7.1**	2.2**	2.4**	1.1NS	2.2**	3.3**	1.5NS

TEST B501. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

48 entries x 8 reps., RCB(E)
1-row plots, 18 ft. long

Planted: September 14, 2000
Harvested: May 17, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Commercial checks								
Phoenix	Spreckels, March 2000	9273	26.41	17.47	204	0.0	97.7	100
Beta 4430R	010269FH2, 9-8-00	10119	28.39	17.86	225	0.0	95.6	96
HH142	Spreckels, 9-7-00	8282	24.21	17.25	193	0.3	97.9	101
Beta 4776R	010228FH2, 9-8-00	7907	22.78	17.40	231	0.0	96.5	92
Checks								
US H11	1999 production	6134	19.49	15.87	212	0.0	94.7	106
R078H50	F92-790-15CMS x R978 (C78)	9323	26.78	17.38	211	2.4	95.9	95
R078H5	9833-5(T-O)HO x R978 (C78)	7597	21.77	17.37	200	0.0	97.2	63
0941H5	9833-5(T-O)HO x RZM 9941	7398	21.51	17.34	188	0.0	96.1	67
Retests from 2000								
9924-6H50	C790-15CMS x 7924-6	8756	24.98	17.61	203	0.0	95.3	51
9929-45H50	x 7929-45VY	10071	28.51	17.67	188	0.7	96.5	82
9929-47H50	x 7929-47VY	7376	21.38	17.43	211	0.7	95.0	103
9929-62H50	x 7929-62VY	9466	28.07	16.97	190	0.0	97.5	98
9930-35H50	x 7930-35VY	8450	23.22	18.22	199	0.0	95.6	78
9927-4H50	x 7927-4VY	9774	28.65	17.08	201	0.3	95.9	116
Sources of progeny lines								
0931H50	C790-15CMS x RZM 9931	8603	25.11	17.25	209	1.0	96.1	93
0747H50	x 7747	7906	23.46	16.92	223	0.0	96.2	64
0936H50	x 8936	8906	25.57	17.44	187	0.0	96.1	81
0942H50	x RZM-% R576-89-18H18,19	8160	23.62	17.27	212	1.5	96.2	61
0941H50	x RZM 9941	8401	24.15	17.32	202	0.3	96.1	90
Z025H50	x RZM Z925	9277	26.89	17.22	189	0.3	95.4	75

TEST B501. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	Mean
Sources of progeny lines (cont.)								
CR011H50	x RZM CR910,11,12	9107	26.66	17.06	199	2.6	95.6	80
0934H50	x RZM 9934	9129	26.67	17.09	207	0.0	96.1	58
0926H50	x RZM-% 8926(Sp)	9277	26.41	17.53	208	0.0	95.4	72
P012H50	x PMR-RZM P912	9645	28.82	16.74	201	9.7	96.4	64
Increases of selected lines								
CR009-1H50	99-790-15CMSxCR909-1(CR09-1)	8453	25.36	16.61	195	2.2	95.8	69
Z025-9H50	x Z825-9 (CZ25-9)	7919	21.87	18.07	220	0.0	96.3	77
0929-112H50	x 8929-112	8405	23.50	17.93	190	2.3	95.7	61
0929-114H50	x 8929-114	7522	21.56	17.53	203	1.0	93.5	33
0930-19H50	x 8930-19	9120	26.27	17.32	208	0.0	95.8	49
0927-29H50	x 8927-29	7669	22.05	17.49	198	0.0	95.0	68
0911-4-10H50(Sp)	x 9911-4-10(C)mm	7304	20.83	17.55	193	2.2	93.4	43
N030-5H50	C790-15CMS x RZM-NR N930-5	7421	21.68	17.07	209	0.4	93.8	57
Selected s_1 lines								
0931-5H50	C790-15CMS x 8931-5	9340	27.20	17.19	202	0.0	93.7	79
0931-7H50	x 8931-7	8531	24.51	17.34	218	0.0	95.1	43
0934-5H50	x 8934-5	8862	25.50	17.36	190	0.3	95.1	60
0935-25H50	x 8935-25	8235	22.86	18.04	196	0.0	96.0	55
0936-8H50	x 8936-8	7250	19.64	18.35	192	0.0	97.2	37
0936-10H50	x 8936-10	9846	28.24	17.38	219	0.0	96.9	83
0936-11H50	x 8936-11	9124	26.70	17.06	200	0.0	97.1	39
0936-16H50	x 8936-16	5961	16.51	18.17	202	0.3	93.2	41

TEST B501. EVALUATION OF HYBRIDS WITH S_1 PROGENY LINE POLLINATORS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Hybrids to C833-5CMS								
0931H5	9833-5(T-O)HO x RZM 9931	8865	24.89	17.81	197	0.0	97.6	46
Z025H5	x RZM Z925	9193	26.17	17.53	204	0.0	95.7	39
CR009-1H5	9833-5HO x CR909-1 (CR09-1)	7857	22.12	17.81	202	0.0	95.6	56
Z025-9H5	x Z825-9 (CZ25-9)	7583	20.54	18.42	205	0.0	95.6	45
0929-112H5	x 8929-112	9165	24.66	18.55	204	0.7	96.6	43
0929-114H5	x 8929-114	8175	22.69	18.02	215	0.0	96.0	38
0930-19H5	x 8930-19	8193	23.03	17.86	206	0.0	97.0	42
0927-29H5	x 8927-29	7061	19.73	17.88	216	0.3	96.8	60
Mean		8445.6	24.20	17.48	203.6	0.6	95.9	67.7
LSD (.05)		1312.8	3.77	0.63	18.6	1.5	2.4	41.4
C.V. (%)		15.8	15.81	3.66	9.3	243.5	2.6	62.1
F value		4.1**	4.42**	4.76**	2.4**	8.3**	1.6*	2.2NS

See Test B301 for same entries under less severe rhizomania. After harvest in 2001 at Salinas, see Tests 101, 201, 301 & 401 for bolting evaluation; 4301 & 4501 for *Erwinia* and powdery mildew evaluation ; 2201 & 3401 for yield performance; and 6201 & 7401 for performance under rhizomania.

Test B501 was grown under moderate rhizomania conditions, however, the infestation and disease development were not uniform. This variation in disease appeared to cause this test to have high CV's. Test B501 was grown under nitrogen status so that despite rhizomania, sugars were relatively high and root yields low. Rankings, however, appeared to be similar to test B301.

See notes for B301 for details on breeding materials and lines.

TEST B601. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

48 entries x 8 reps., RCB(E), 3 tiers per rep
1-row plots, 18 ft. long, 24 tiers, 16 rows

Planted: September 14, 2000
Harvested: May 18, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Commercial checks								
Beta 4776R	010228FH2, 9-8-00	8279	22.99	18.05	190	0.0	97.3	64
Beta 4430R	010269FH2, 9-8-00	9937	27.40	18.14	192	0.0	96.6	64
Phoenix	March 2000	10197	29.08	17.66	192	0.0	98.3	67
HH142	HH142, 9-7-00	8590	24.38	17.66	170	0.0	98.1	86
Hybrids with FS lines								
Y067H50	92-C790-15CMS x RZM Y967(C67)	8926	24.73	18.07	197	0.4	96.4	48
Y067-3H50	C790-15CMS x Y867-3	9701	27.17	17.80	195	0.7	96.9	72
Y072-4H50	x Y872-4	9116	26.41	17.31	195	0.0	96.6	74
R076-89-H50	x RZM R976-89R	7992	22.78	17.75	183	1.5	95.0	61
R976-89-18H50	x C76-89-18	9885	27.65	17.92	200	1.2	96.6	58
R076-89-5H50	x C76-89-5,NB	7808	22.24	17.62	193	0.0	96.8	55
R076-89-5-9H50	x R876-89-5NB-9	7415	21.00	17.69	201	0.0	96.0	55
Y068-1H50	x Y868-1	7798	21.54	18.09	190	0.0	96.6	64
Y068-2H50	x Y868-2	8477	24.21	17.47	185	0.0	94.8	72
Y068-4H50	x Y868-4	9083	25.49	17.89	179	0.5	96.9	49
Y068-6H50	x Y868-6	8038	22.90	17.63	195	0.7	96.6	72
R070-9H50	x R870-9	7661	21.16	18.11	202	0.3	95.5	59
Hybrids with FS lines								
R078H50	92-790-15CMS x R978 (C78)	7797	21.29	18.25	191	0.7	94.8	44
R078-3H50	C790-15CMS x R878-3	9422	27.64	17.09	193	0.3	97.2	95
R078-4H50	x R878-4	9829	27.82	17.58	188	0.0	95.7	68
R078-8H50	x R878-8	8909	25.68	17.33	192	0.0	95.4	73
R078-9H50	C790-15CMS x R878-9	7654	21.73	17.77	184	0.0	96.7	58

TEST B601. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Hybrids with FS lines (cont.)								
R980H50	C790-15CMS x RZM-ER-% R780/2(C80)	8693	24.29	17.86	190	0.7	96.4	55
R080-5H50	x R880-5	7643	21.37	17.85	206	2.0	95.8	50
R080-9H50	x R880-9	8486	23.59	18.01	184	0.0	93.9	59
R080-13H50	x R880-13	8277	23.20	17.91	194	0.0	94.7	59
R080/2-9H50	x R880/2-9	8365	23.18	18.08	192	0.0	94.8	45
R080/2-11H50	x R880/2-11	8779	25.21	17.43	179	0.8	96.2	60
R080-45-10H50	x R880-45-10	7940	22.65	17.69	185	0.0	96.1	53
Y969H50(Iso)	x RZM-ER-% Y769(C69)	8668	24.29	17.86	183	0.4	95.5	76
Y069-13H50	x Y869-13	8906	24.55	18.18	196	0.0	96.7	60
Y069-18H50	x Y869-18	9065	24.93	18.13	188	0.4	97.2	48
Y069-26H50	x Y869-26	7578	21.11	17.93	209	0.0	96.3	84
Hybrids with O.P. lines & *Bvm* gp								
Y075H50	92-790-15CMS x RZM-% Y875	9656	27.04	17.86	192	1.5	96.5	63
Y071H50	C790-15CMS x RZM Y971	9004	25.42	17.73	198	0.0	96.4	36
P007/8H50	x PMR-RZM P807,8-#(C)	9587	26.53	18.10	188	0.3	95.4	48
P007H50	x PMR-RZM P907	9171	26.06	17.63	182	5.4	97.7	46
P019H50	x PMR-RZM P919-#(C)	10012	27.86	17.98	208	2.2	96.4	41
P020H50	x PMR-RZM P920-#(C)	8519	23.48	18.08	188	1.9	95.9	45
R036H50	x RZM R936(C79-8)	8994	26.18	17.15	192	1.8	97.0	69
R021H50	99-790-15CMS x R926,7(C26,C27)	7956	22.08	17.96	187	3.9	95.3	36
Hybrids with C833-5CMS								
R078H5	9833-5(T-O)HO x R978 (C78)	7868	21.48	18.38	177	0.0	97.0	38
R076-89-18H5	x RZM C76-89-18	9134	25.90	17.63	191	1.2	97.5	71
R021H5	x R926,7(C26,C27)	8140	23.20	17.51	186	2.7	94.6	62
0931H5	x RZM 9931(C)	7621	21.23	17.88	188	0.4	95.2	42

TEST B601. EVALUATION OF HYBRIDS WITH SELF-STERILE POLLINATORS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description		Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Hybrids with C833-5CMS (cont.)									
CR009-1H5	9833-5HO	x CR909-1(CR09-1)	7821	21.80	17.95	190	0.0	94.9	37
Z025-9H5		x Z825-9(CZ25-9)	7913	20.76	19.04	179	0.0	96.2	35
0930-19H5		x 8930-19	8694	23.78	18.20	190	0.0	96.7	29
0927-29H5		x 8927-29	5382	14.78	18.21	186	0.0	96.2	34
Mean			8549.7	23.99	17.86	190.3	0.7	96.2	57.0
LSD (.05)			1232.9	3.63	0.73	18.4	1.6	1.8	40.1
C.V. (%)			14.6	15.36	4.14	9.8	245.7	1.9	71.4
F value			4.1**	4.11**	1.65NS	1.4NS	3.7**	2.2**	
1.1NS									

See Tests B201 for same entries under less severe rhizomania. After harvest in 2001 at Salinas, see Tests 101, 201, 301 & 401 for bolting evaluation; 4301 & 4501 for *Erwinia* and powdery mildew evaluation; 2201 & 3301 for yield performance; and 6201 and 7301 for performance under rhizomania.

Test B601 was grown under moderate rhizomania conditions, however, the infestation and disease development were not uniform, thus the high CV's relative to test B201. Test was grown under low nitrogen status and powdery mildew was not controlled.

Full-sib pollinators: Multigerm breeding lines have been developed and improved. From these, FS families were generated and tested at Salinas, Brawley, and Davis. On the basis of these tests, selected FS lines were testcrossed to a common mm CMS tester and increased. This is a test of these testcross hybrids. On the basis of these tests, a few lines may be further advanced and eventually released. the best will be recombined.

NOTES: 9833-5(T-O)HO and 9833-5HO = C833-5CMS. C790-15CMS = C790-68CMS x C790-15. Full-sibs were generated from breeding lines C67,C72,C76-89-5,Y68,R70,R78(C78),C80 & C69. P#-lines have powdery mildew resistance (*Pm*) from WB97 & 242.

TEST B801. SCREENING FULL-SIB AND S_1 PROGENY FOR PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

96 entries x 2 reps., sequential
1-row plots, 18 ft. long

Planted: September 14, 2000
Harvested: June 6, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Score	Root Rot %	Appear Score Mean
Checks										
Beta 4430R	010269FH2, 9-8-00	9455	30.03	15.98	183	0.0	98.4	209	0.0	2.8
Phoenix	March 2000	6281	22.33	14.27	175	0.0	97.2	354	0.0	2.8
US H11	1999 production	6013	22.24	13.72	192	0.0	95.7	287	0.0	2.5
Y067	RZM Y967 (C67)	7289	25.14	14.48	206	0.0	98.0	258	0.0	1.8
Y071	RZM Y971	6855	25.70	13.49	225	1.1	96.4	240	1.1	2.0
99-C31/6	Inc. F86-31/6 (C31/6)	6831	23.15	14.68	203	0.0	97.5	185	0.0	2.5
Y090	Inc. FS sel.(Y67,Y68,R78,R80)	8145	28.27	14.56	186	0.0	95.2	255	0.0	2.0
Y075	RZM-%S Y875	7238	24.01	15.10	217	3.8	97.2	213	0.0	1.8
FS's from Y67 (C67)										
Y067 - 1	RZM Y967 PX	6957	21.65	15.89	153	0.0	95.7	200	0.0	1.8
- 2		5975	20.02	14.63	153	0.0	97.1	198	0.0	2.8
- 3		7821	24.30	16.15	178	0.0	96.4	103	3.3	2.0
- 4		6922	24.30	14.24	181	0.0	96.9	199	0.0	2.0
- 5		8734	27.97	15.68	206	2.5	98.0	86	0.0	1.5
- 6		5786	19.30	15.05	161	0.0	94.6	125	0.0	2.5
- 7		5731	22.09	12.94	150	0.0	96.1	206	0.0	2.3
- 8		5707	18.45	15.47	203	0.0	97.7	172	0.0	3.0
- 9		10289	33.96	15.16	156	0.0	97.5	146	0.0	1.8
-10		7763	23.69	16.38	175	0.0	97.2	109	0.0	1.8
-11		6284	20.29	15.68	181	4.5	96.5	116	0.0	2.3
-12		9544	28.26	16.92	172	1.7	97.6	112	0.0	2.3

TEST B801. SCREENING FULL-SIB AND S_1 PROGENY FOR PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Clean Beets	NO3-N	Root Rot	Appear Score
		Lbs	Tons	%	No.	%	%	Score	%	Mean
FS's from Y67 (cont.)										
Y067 -13	RZM Y967 PX	8133	26.29	15.41	192	0.0	96.1	135	0.0	2.3
-14		8631	27.91	15.41	175	0.0	95.7	187	0.0	2.8
-15		9554	27.37	17.42	164	0.0	95.9	83	0.0	1.5
-16		6776	21.85	15.49	192	0.0	96.6	172	0.0	2.5
-17		4947	17.64	14.00	181	0.0	98.2	220	2.9	3.5
-18		8917	30.08	14.82	175	0.0	98.0	168	0.0	1.8
-19		6885	20.80	16.49	189	2.8	96.5	147	0.0	3.0
-20		6303	19.62	16.09	195	0.0	97.8	98	0.0	2.8
-21		9329	27.44	16.99	209	1.3	96.9	109	0.0	1.8
-22		5159	15.86	16.24	192	0.0	96.3	64	0.0	3.3
-23		6721	22.98	14.66	161	0.0	95.0	193	0.0	3.0
-24		7815	24.24	16.11	170	0.0	97.4	155	0.0	1.5
Y067 -25	RZM Y967 PX	7748	24.43	15.83	175	0.0	98.0	174	0.0	2.0
-26		6944	20.61	16.80	150	0.0	97.9	122	0.0	3.0
-27		9431	30.91	15.26	178	0.0	98.2	181	0.0	1.8
-28		6067	18.29	16.72	189	0.0	98.1	65	0.0	2.5
-29		8818	31.43	14.38	222	0.0	97.8	150	1.2	2.8
-30		9881	31.87	15.40	172	0.0	97.5	214	0.0	2.0
FS's from Y71										
Y071 - 1	RZM Y971 PX	5992	18.21	16.42	145	0.0	94.5	89	0.0	2.8
- 2		6723	21.03	16.02	175	0.0	95.6	118	0.0	2.3
- 3		4709	16.99	13.76	192	7.8	97.4	233	1.3	4.0
- 4		6622	22.69	14.59	156	0.0	96.7	123	0.0	2.3
- 5		8462	26.49	16.03	175	0.0	96.9	149	1.5	2.8
- 6		6133	18.48	16.38	189	0.0	96.7	69	0.0	2.8

TEST B801. SCREENING FULL-SIB AND S_1 PROGENY FOR PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Score	Root Rot %	Appear Score Mean
FS's from Y71 (cont.)										
Y071 - 7	RZM Y971 PX	8999	29.90	15.09	222	1.2	96.3	78	0.0	1.5
- 8		7960	26.57	14.98	150	0.0	97.2	201	0.0	3.3
- 9		7124	25.30	14.10	167	0.0	96.1	196	0.0	2.5
-10		6102	19.01	16.06	195	0.0	97.0	145	1.5	2.8
-11		6617	22.44	14.72	186	0.0	97.6	164	4.5	3.0
-12		6722	21.80	15.44	164	0.0	95.8	115	0.0	2.3
-13		7329	22.54	16.28	167	0.0	97.1	104	0.0	2.3
-14		6620	19.52	17.06	183	0.0	96.5	83	0.0	2.0
-15		5196	17.80	14.59	206	0.0	96.8	97	0.0	2.0
-16		9143	28.28	16.16	133	0.0	98.2	125	0.0	2.5
-17		4444	15.06	14.75	161	0.0	96.1	116	1.8	3.5
-18		6121	19.72	15.54	170	0.0	97.0	99	0.0	3.3
FS's from Y75										
Y075 - 1	RZM Y975 PX	7521	25.49	14.66	150	0.0	97.6	193	0.0	2.5
- 2		7913	28.24	14.01	145	0.0	96.4	313	0.0	2.3
- 3		5688	18.49	15.61	153	0.0	96.7	73	0.0	4.0
- 4		6259	22.28	14.06	181	0.0	95.6	139	0.0	2.5
- 5		7016	22.95	15.28	181	0.0	96.8	115	0.0	2.3
- 6		3527	11.13	15.85	145	0.0	96.5	130	0.0	4.0
- 7		7440	26.60	14.01	167	0.0	95.6	156	3.7	2.5
- 8		4247	13.57	15.68	181	0.0	95.6	113	0.0	3.5
- 9		7756	25.80	15.02	167	0.0	96.1	224	0.0	2.8
-10		5030	17.12	14.88	175	7.5	95.4	115	5.4	3.8
-11		5379	21.01	12.74	161	0.0	96.4	228	3.3	3.3
-12		6640	22.11	15.01	178	0.0	96.8	223	0.0	2.8

TEST B801. SCREENING FULL-SIB AND S_1 PROGENY FOR PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Clean Beets	NO3-N	Root Rot	Appear Score
		Lbs	Tons	%	No.	%	%	Score	%	Mean
FS's from Y75 (cont.)										
Y075 -13	RZM Y975 PX	3751	12.26	15.25	197	0.0	95.6	108	0.0	3.5
-14		4979	16.72	14.76	164	18.6	94.6	165	0.0	3.8
-15		3800	13.05	14.60	158	0.0	93.3	151	0.0	3.3
-16		6948	20.86	16.65	164	0.0	96.8	128	0.0	2.8
-17		5220	16.77	15.56	183	9.1	96.2	84	1.5	3.0
-18		8678	26.40	16.42	164	0.0	97.4	136	0.0	2.0
FS's from R43										
R043 - 1	RZM R943 PX	9478	29.13	16.26	178	0.0	97.1	103	0.0	2.5
- 2		5975	19.32	15.49	161	0.0	96.1	98	0.0	3.3
- 3		7409	23.15	16.02	209	0.0	94.9	66	0.0	3.0
- 4		7690	25.27	15.22	167	10.2	95.0	115	0.0	2.3
- 5		4629	15.28	15.33	161	1.7	95.6	132	1.7	3.3
- 6		6935	21.29	16.28	175	0.0	95.1	75	0.0	3.3
- 7		6275	20.57	15.28	195	13.0	96.5	129	0.0	2.8
- 8		7975	26.50	15.05	161	3.7	96.9	106	7.2	3.8
- 9		7642	26.65	14.44	181	0.0	97.4	149	0.0	3.3
-10		7106	24.17	14.62	195	40.4	95.3	161	0.0	3.3
-11		7126	21.78	16.41	197	0.0	97.8	97	0.0	3.3
-12		6486	21.05	15.40	170	66.5	95.6	115	1.9	3.5
-13		6918	21.73	15.90	133	2.2	95.6	117	4.0	2.5
-14		6608	20.11	16.44	156	5.0	96.6	81	1.4	3.3

TEST B801. SCREENING FULL-SIB AND S_1 PROGENY FOR PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Score	Root Rot %	Appear Score Mean
S_1's from popn-934										
0934 - 1	RZM 9934⊗	4236	15.87	13.42	156	0.0	93.3	190	3.3	3.5
- 2		6000	19.71	15.22	164	0.0	97.0	98	5.4	4.5
- 3		7581	24.79	15.27	170	0.0	94.9	176	5.0	2.5
- 4		5280	17.05	15.40	181	0.0	97.8	136	0.0	3.0
- 5		2799	9.03	15.50	147	0.0	95.5	105	2.1	3.0
- 6		3674	12.59	14.54	197	0.0	96.2	120	2.9	3.8
- 7		6606	23.41	14.22	106	0.0	96.8	125	0.0	3.0
- 8		3091	11.29	13.70	145	0.0	95.1	112	9.7	3.5
Mean		6770.9	22.16	15.29	174.9	2.1	96.5	146.7	96.5	2.7
LSD (.05)		2396.7	7.89	1.76	44.4	5.5	3.0	108.9	3.0	1.0
C.V. (%)		17.8	17.93	5.81	12.8	128.7	1.6	37.4	1.6	18.1
F value		3.5**	3.20**	2.29**	1.8**	18.3**	1.0NS	2.2**	1.0NS	3.7**

See Test B1201 for some of these progeny lines under severe rhizomania.

Test B801 was grown under moderate rhizomania in Field K. The primary purpose of this test was to identify progeny families (FS's and S_1's) that performed best under rhizomania in the Imperial Valley. Most of these progenies have resistance to rhizomania derived from C51(R22,*Bvm*). From C51, some genotypes have very high resistance to rhizomania under high temperature conditions. The combination of sugar yield components and appearance score were used to identify these genotypes. Also, residual annualism ocurs in this material, and nonbolting, biennials will be selected.

Appearance score (= beauty score) of canopy prior to harvest. Mean scores were from ratings made 5/16/01 and 6/4/01 where 1 is best and 5 is worst. 1 = estimated to be how canopy (size, color, vigor, …) would look in the absence of rhizomania. 5 = plants stunted, dead or dying, and in very poor general health. Scores 3 thru 5 are types that were thought would not survive under rhizomania in the high temperatures of mid-summer.

TEST B1001. EVALUATION OF EXPERIMENTAL HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER SEVERE CONDITIONS, IMPERIAL VALLEY, CA., 2000-2001

80 entries x 2 reps., sequential
1-row plots, 14 ft. long

Planted: September 14, 2000
Not harvested for yield

Variety	Description	Stand Count No.	Appearance Score 05/16	Appearance Score 06/04	Appearance Score Mean	Bolting %
Checks						
Beta 4776R	010228FH2, 9-8-00	27.5	2	4	2.8	0.0
US H11	1999 seed	32.5	3	4	3.5	0.0
R522(Sp)	RZM-5S R322R4,…(C51)	27.0	2	3	2.3	14.9
R522R5	RZM R322R4,…	24.0	2	3	2.0	10.3
HH142	rec'd 9-7-00	24.5	4	4	3.8	0.0
Experimental lines & hybrids						
0808-15H5	9833-5(T-O)HO x 8808-15	26.0	3	4	3.3	0.0
0808-9H5	9833-%(T-O)HO x 8808-9	27.0	3	4	3.3	0.0
00-C37	Inc. U86-37	28.0	4	5	4.0	0.0
N030-5H50	C790-15CMS x RZM-NR N930-5	31.5	3	5	3.5	0.0
N065H5	9833-5(T-O)HO x RZM N965m	24.5	3	4	3.5	0.0
Experimental hybrids						
9927-4H50	C790-15CMS x 7927-4VY	25.0	1	2	1.3	0.0
0927-29H50	C790-15CMS x 8927-29	28.0	3	4	3.0	0.0
0927-29H5	9833-5HO x 8927-29	28.5	4	5	4.0	0.0
0927-29H55	8835HO x 8927-29	28.5	4	5	4.0	0.0
0934-5H50	C790-15CMS x 8934-5	25.5	3	4	3.3	0.0
Y067-3H50	C790-15CMS x Y867-3	28.5	2	3	2.0	0.0
Y072-4H50	C790-15CMS x Y872-4	30.5	1	2	1.5	0.0
US H11	1999 seed production	28.5	4	5	4.3	0.0
P007H50	C790-15CMS x PMR-RZM P907	28.5	3	3	3.0	0.0
P007/8H50	C790-15CMS x PMR-RZM P807,8(C)	25.5	3	3	2.5	0.0
P019H50	C790-15CMS x PMR-RZM P919(C)	28.0	3	4	3.0	0.0
P020H50	C790-15CMS x PMR-RZM P920(C)	29.5	3	4	3.5	0.0
P012H50	C790-15CMS x PMR-RZM P912	27.5	4	4	3.8	0.0
R940H50	C790-15CMS x RZM-ER-% R740	23.5	3	4	3.0	0.0
0921	RZM 9926aa x R926,7	26.5	3	4	3.3	0.0
0934H50	C790-15CMS x RZM 9934	28.5	2	3	2.3	0.0
Y067H50	C790-15CMS x RZM Y967	29.0	2	3	2.3	0.0
Y071H50	C790-15CMS x RZM Y971	29.0	3	4	3.0	0.0
Y075H50	C790-15CMS x RZM-%S Y875	31.0	3	3	2.8	0.0
0926H50	C790-15CMS x RZM-%S 8926	26.0	3	4	3.3	0.0
R036H50	C790-15CMS x RZM R936	26.0	2	3	2.3	0.0
B4430R	010269FH2, 9-8-00	29.5	2	3	2.3	0.0
R021H50	C790-15CMS x R926,7	27.5	3	3	2.8	0.0
R021H5	9833-5(T-O)HO x R926,7	26.0	3	4	3.0	0.0
R021H55	9835(T-O)HO x R926,7	29.0	3	4	3.3	0.0

TEST B1001. EVALUATION OF EXPERIMENTAL HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER SEVERE CONDITIONS, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Stand Count	Appearance Score			Bolting
		No.	05/16	06/04	Mean	%
Topcrosses to R78						
R078H50	92-790-15CMS x R978	26.5	3	3	3.0	0.0
R078H5	9833-5(T-O)HO x R978	27.0	3	3	3.0	0.0
R078H55	9833(T-O)HO x R978	26.5	3	4	3.3	0.0
R078H37	4807HO (C306/2HO) x R978	28.5	4	4	4.0	0.0
R078H9	RZM 9808aa x R978	26.0	4	3	3.3	0.0
R078H17	RZM 9808H50 x R978	24.5	4	4	3.5	0.0
R078H18	RZM 9818HO x R978	26.0	2	2	2.0	2.2
R078H19	RZM 9818aa x R978	27.0	3	2	2.3	0.0
R078H48 - 1	9848 - 1aa x R978	26.0	3	3	3.0	0.0
- 2	- 2aa	22.5	3	4	3.3	0.0
- 3	- 3aa	23.0	2	2	2.0	2.0
- 4	- 4aa	27.0	3	3	2.8	0.0
- 6	- 6aa	25.0	4	4	3.5	0.0
- 7	- 7aa	26.0	3	3	2.5	0.0
- 8	- 8aa	27.5	4	4	4.0	0.0
- 9	- 9aa	24.5	3	3	2.5	0.0
-10	-10aa	26.0	3	4	3.3	0.0
-11	-11aa	28.5	4	4	3.5	0.0
-12	-12aa	24.0	4	3	3.3	0.0
R078H10 - 1	9810 - 1aa x R978	23.0	2	2	2.0	0.0
- 2	- 2aa	26.0	3	4	3.0	0.0
- 3	- 3aa	26.5	4	4	3.5	0.0
- 4	- 4aa	26.5	3	4	3.3	0.0
- 5	- 5aa	20.0	4	4	3.8	0.0
- 6	- 6aa	26.0	3	3	2.5	0.0
- 8	- 8aa	24.0	3	4	3.0	0.0
- 9	- 9aa	20.0	3	3	2.8	0.0
-10	-10aa	17.5	3	4	3.0	0.0
-11	-11aa	25.5	4	4	4.0	0.0
-12	-12aa	25.0	4	4	3.8	0.0
-14	-14aa	26.0	3	4	3.5	0.0
-15	-15aa	25.5	3	3	2.5	0.0
-16	-16aa	22.5	4	4	4.0	0.0
-17	-17aa	25.0	3	3	2.8	0.0
-18	-18aa	19.0	4	4	3.8	0.0
-19	-19aa	27.5	2	3	2.0	0.0
-20	-20aa	24.5	3	4	3.0	0.0

TEST B1001. EVALUATION OF EXPERIMENTAL HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER SEVERE CONDITIONS, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Description	Stand Count No.	Appearance Score 05/16	Appearance Score 06/04	Appearance Score Mean	Bolting %
R078H15 - 2	9815 - 2aa x R978	25.5	3	4	3.3	0.0
- 3	- 3aa	26.5	4	4	3.8	0.0
- 5	- 5aa	21.5	3	3	2.8	0.0
- 7	- 7aa	24.5	3	3	2.8	0.0
- 8	- 8aa	28.0	3	4	3.5	0.0
- 9	- 9aa	27.5	4	4	3.8	0.0
-10	-10aa	22.5	4	5	4.0	0.0
-11	-11aa	21.0	3	4	3.0	0.0
Mean		26.1	2.8	3.3	3.1	0.4
LSD (.05)		6.5	1.6	1.2	1.2	1.0
C.V. (%)		12.5	28.4	18.4	20.0	137.7
F value		1.4NS	1.4NS	2.7**	2.2**	32.3**

NOTES: Test B1001 was designed to evaluate visually experimental hybrids for reaction to severe rhizomania in Imperial Valley. Entries usually had at least one component that was partially derived from C51(R22) or other *Bvm* germplasm. Factors in this germplasm are known to condition higher resistance to rhizomania than *Rz* alone.

A visual appearance score was used to evaluate this material where 1 = very good to 5 = very poor. (See notes for Test B701 & B801).

The extreme differences sometimes observed in the past for these types of tests did not occur. This may in part have been due to a lower nitrogen status and even the best material had small canopies. Nevertheless, differences were great enough to differentiate the *Bvm* type resistance from just the *Rz* resistance. Lines or hybrids produced from lines that had previously been identified and selected as having the best resistance were again good. These included R522 lines, 9927-4H50 from 7927-4VY (C927-4), Y867-3 from C67, Y872-4 from C72, P007/8 from PMR (*Pm*) germplasm lines WB97 & WB242.

Monogerm S_1 progenies were also screened as topcross hybrids. These mmS_1's had a small amount of R22 germplasm in their background (see Test B701).

TEST B1101. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER SEVERE CONDITIONS, IMPERIAL VALLEY, CA, 2000-2001

64 entries x 4 reps., sequential
1-row plots, 14 ft. long

Planted: September 14, 2000
Not harvested for yield

Variety	Description	Stand Count	Appearance Score			Bolting
		No.	05/16	06/04	Mean	%
Checks						
Rizor	HH108, 9-3-97	24.8	4	4	3.6	0.0
HH142	rec'd 9-7-00	21.8	4	4	3.5	0.0
Alpine	X612401, 9-10-99	25.0	4	4	3.6	0.0
Phoenix	March 2000	25.5	4	4	4.0	0.0
US H11	1999 seed	27.0	4	4	3.9	0.0
R522(Sp)	RZM-%S R322R4,…(C51)	23.5	2	2	2.0	22.5
B4776R	010228FH2, 9-8-00	27.0	3	3	3.0	0.0
B4430R	010269FH2, 9-8-00	25.5	3	3	3.0	0.0
Multigerm, S^sS^s lines						
99-C46/2	Inc. U86-46/2	27.8	3	4	3.5	0.0
R078(Iso)	Inc. R978	25.3	3	4	3.3	0.0
R078(Sp)	Inc. R978	21.5	4	4	3.9	0.0
Y967	RZM-ER-% Y767	27.0	2	3	2.4	0.9
Y067	RZM Y967	25.0	2	3	2.3	0.0
Y067-3	Inc. Y867-3	23.0	3	3	2.6	0.0
Y975	RZM Y875	24.0	2	3	2.4	1.3
Y075	RZM-%S Y875	23.0	2	2	2.1	1.9
Y072-4	Inc. Y872-4	25.8	2	3	2.3	0.0
Y090	Inc. FS sel.(Y67,Y68,R78,R80)	23.3	3	4	3.4	0.0
R076-89	RZM R976-89R	26.0	4	5	4.4	0.0
R039	Inc. R539 (C39R)	23.8	3	4	3.5	0.0
00-FC1014	RZM-%S FC 951014mm	25.3	5	4	4.5	0.0
00-FC123	RZM 99-FC123mm	23.0	5	5	4.6	0.0
00-EL02/04	RZM 99-EL02/04	25.0	4	4	3.5	0.0
Y071	RZM Y971	21.0	3	4	3.4	0.0
R021	RZM R926,R927	24.5	3	4	3.4	1.0
R036	RZM R936, (C79-8,R22)	24.3	4	4	3.6	0.0
00-C37	Inc. U86-37, (C37)	28.0	4	5	4.4	0.0
R940	RZM-ER-% R740	26.0	3	4	3.4	2.1
R879	RZM R779, (C79-1*Rz*)	20.3	4	5	4.5	0.0
R926	RZM R826, (C26)	22.8	3	3	2.8	0.9
R927	RZM R827, (C27)	24.8	3	4	3.3	0.0
99-C31/6	Inc. F86-31/6	24.8	4	3	3.4	0.0

TEST B1101. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER SEVERE CONDITIONS, IMPERIAL VALLEY, CA, 2000-2001

(cont.)

Variety	Description	Stand Count No.	Appearance Score 05/16	Appearance Score 06/04	Appearance Score Mean	Bolting %
Multigerm, S^sS^s lines (cont.)						
US H11	1999 seed	28.5	4	4	3.8	0.0
R522(Sp)	RZM-%S R322R4,…(C51)	20.8	2	3	2.5	21.7
N499	Inc. 3T1442,…;SBCNR *Bvm*	23.8	2	3	2.4	43.1
Y969(Iso)	RZM-ER-% Y769, (C69)	24.0	4	4	3.5	0.0
N972	RZM N872, N771(C) (SBCNR)	24.3	2	2	2.0	12.1
99-WB242	Inc. WB242, (PMR,SBCNR)	23.3	1	2	1.8	28.0
00-C37	Inc. U86-37	26.0	4	4	4.0	0.0
P007/8	PMR-RZM P807,8(C)	24.8	2	2	1.9	0.0
P007	PMR-RZM P907	24.0	2	2	1.9	0.0
P017	PMR-RZM P917(C)	25.3	4	4	3.9	0.0
P018	PMR-RZM P918(C)	24.8	3	3	3.0	3.8
P019	PMR-RZM P919(C)	25.3	4	3	3.4	0.0
P020	PMR-RZM P920(C)	25.8	3	4	3.5	0.0
P012	PMR-RZM P912	24.3	3	4	3.1	4.6
Multigerm, S^f,Aa populations						
0747	Inc. 7747 (A,aa)	26.3	4	4	4.0	0.0
0931	RZM 9931aa x A	23.0	3	4	3.6	0.0
0926	RZM-%S 8926(Sp)_	24.0	2	3	2.5	0.0
0921	9926aa x RZM R926,R927	21.8	3	3	2.5	0.0
0934	RZM 9934 (A,aa)	22.0	2	3	2.5	0.0
0934-5	Inc. 8934-5 (A,aa)	24.0	2	3	2.4	0.0
0927-29	8927-29aa x A	21.5	5	5	4.9	0.0
0930-19	8930-19aa x A	24.3	4	4	4.1	0.0
Z025-9	Z825-9aa x A	20.5	5	5	4.6	0.0
CR009-1	CR901-1aa x A	23.0	5	5	5.0	0.0
CR011	RZM CR910,11,12aa x A	23.5	4	4	3.8	0.0
Z025	RZM Z925aa x A	22.8	4	4	3.8	0.0
N024	RZM N925,26,31,32(C)galls	24.5	3	4	3.3	0.0
0941	RZM 9941aa x A	24.3	3	4	3.4	0.0
0929-112	8929-112aa x A	25.0	4	4	3.9	0.0
0929-114	8929-114aa x A	21.3	4	4	3.5	0.0
9927-4	Inc. 7927-4VY	26.5	1	3	1.9	0.0
0848M	RZM-%S 8848,8810	23.3	4	4	3.5	0.0

TEST B1101. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER SEVERE CONDITIONS, IMPERIAL VALLEY, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	Appearance Score			Bolting
		No.	05/16	06/04	Mean	%
Mean		24.2	3.2	3.4	3.3	2.2
LSD (.05)		4.3	0.7	0.8	0.6	5.2
C.V. (%)		12.8	16.5	15.8	13.6	166.3
F value		1.4*	12.0**	7.8**	13.2**	15.8**

Test B1101 was designed to evaluate visually breeding lines for reaction to severe rhizomania under high temperatures. Most entries were from the Salinas rhizomania resistance breeding program. Some are derived from C51 (R22) or other *Bvm* germplasm. Factors in this germplasm appear to condition higher resistance to rhizomania than *Rz* alone.

A visual appearance score was used to evaluate this material, where 1 = very good to 5 = very poor. (See notes for Tests B701 & B801).

NOTES: The most resistant breeding material identified by visual appearance was from *Bvm* germplasm and usually had been previously selected for resistance and survivability under rhizomania and high temperature stress conditions. This material included R522(C51), C67 types (Y967,Y067,Y067-3), Y975 & Y075 types that were generated from composites of C67, Y71, C72, etc. lines. Two outstanding lines were 9927-4 (C927-4) with a small C51 component and P007/8 with a component from PMR (*Pm*) WB97 and WB242. Line N024 with nematode resistance from *B.procumbens* and N972 & N499 with nematode resistance from *Bvm* had individual plants that were good, again suggesting that resistance to cyst nematode may be important in this disease complex.

TEST B901. EVALUATION OF HERBICIDE RESISTANT HYBRIDS, IMPERIAL VALLEY, CA., 2000-2001

8 entries x 8 reps., RCB
4-row plots, 27 ft. long

Planted: September 13, 2000
Harvested: June 7, 2001

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean	Powdery Mildew 5/15
Checks									
Beta 4776R	010228FH2	9585	28.00	17.11	178	0.0	97.2	158	6.5
Phoenix	March 2000	10727	32.08	16.74	180	0.0	97.7	176	6.1
Beta 4430R	010269FH2	12896	36.73	17.56	183	0.0	97.8	104	4.4
Roundup-Ready									
HM115RZRR	Novartis Roundup-Ready (9-8-00)	11287	33.00	17.11	175	0.2	96.8	92	5.0
HM123RZRR	Novartis Roundup-Ready (9-8-00)	10721	32.46	16.52	175	0.6	97.4	87	4.1
HM124RZRR	Novartis Roundup-Ready (9-8-00)	11831	34.06	17.38	179	0.1	97.7	62	5.1
7CG9236RR	Betaseed Roundup-Ready (9-8-00)	11377	31.29	18.19	177	0.0	96.6	111	8.0
Liberty-Link									
7CG9236LL	Betaseed Liberty-Link (9-8-00)	10704	29.60	18.11	184	0.1	96.1	99	7.4
Mean		11141.0	32.15	17.34	179.0	0.1	97.2	111.0	5.8
LSD (.05)		590.5	1.68	0.52	16.2	0.5	1.2	41.1	0.6
C.V. (%)		5.3	5.20	2.98	9.0	323.0	1.3	36.8	11.0
F value		21.8**	20.44**	10.72**	0.4NS	1.9NS	2.1NS	6.8**	38.5**

NOTES: Test treated post planting, pre-emergence with Nortron. Then neither Roundup nor Liberty applied. Weeds controlled mechanically. Powdery mildew not controlled. Scored on a scale of 0 to 9 on 5-15-01. All four rows of 4-row plot weighed. Sugar samples only from two middle rows. All beets destroyed in field. Slabs from tare laboratory returned to field.

TEST B901. EVALUATION OF HERBICIDE RESISTANT HYBRIDS, IMPERIAL VALLEY, CA., 2000-2001

(cont.)

Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
Checks								
Beta 4776R	8629	308	90.1	956	356	1960	546	11329
Phoenix	9589	299	89.4	1138	391	2063	557	11817
Beta 4430R	11731	319	90.9	1165	328	1979	474	10596
Roundup-Ready								
HM115RZRR	10216	310	90.5	1070	318	2041	486	10833
HM123RZRR	9640	297	89.9	1080	440	2111	448	11078
HM124RZRR	10736	315	90.7	1095	292	1987	499	10734
7CG9236RR	10365	332	91.1	1013	360	1923	494	10762
Liberty-Link								
7CG9236LL	9779	331	91.4	925	333	1914	468	10393
Mean	10085.8	314.0	90.5	1055.2	352.2	1997.3	496.5	10942.7
LSD (.05)	605.4	12.4	1.4	155.1	71.3	216.6	112.0	1477.0
C.V. (%)	6.0	3.9	1.6	14.6	20.1	10.8	22.5	13.4
F value	18.5**	8.8**	1.8NS	2.4*	3.4**	0.8NS	0.9NS	0.8NS

POWDERY MILDEW CONTROL, IMPERIAL VALLEY, CA, 2000-2001

6 treatments x 5 reps, Latin square
4-row plots, 50 ft. long

Planted:
Harvested: June 7, 2001

Treatment	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Clean Beets %	NO3-N Mean	Powdery Mildew Upper 4/19	Powdery Mildew Lower 4/19	Powdery Mildew Upper 5/16	Powdery Mildew Lower 5/16	Powdery Mildew Upper Mean	Powdery Mildew Lower Mean
1. Eminent	13.0 fl oz/a	11132	32.37	17.18	96.09	66	0.0	0.1	0.2	0.3	0.1	0.2
2. Quadris	15.4 fl oz/a	11007	32.36	17.10	96.22	75	1.5	1.6	1.2	1.6	1.4	1.6
3. Procure	0.5 fl oz/a	10846	31.57	17.19	95.17	70	0.1	0.3	0.6	0.6	0.3	0.5
4. BAS 500 + Latron B-1956	9.2 fl oz/a + 0.06% v/v	11240	32.18	17.43	96.69	69	0.6	0.9	1.1	1.3	0.8	1.3
5. Sulfur	6.0 lbs/a	11811	33.86	17.44	96.60	54	0.0	0.3	0.2	0.4	0.1	0.4
6. Control	Nontreated	10383	30.40	17.11	96.29	69	2.4	2.5	2.2	2.4	2.3	2.4
Mean		11063.9	32.12	17.24	96.18	67.1	0.8	1.0	0.9	1.1	0.8	1.0
LSD (.05)		570.8	1.08	0.67	1.64	38.2	0.6	0.6	0.7	0.8	0.5	0.6
C.V. (%)		4.3	2.79	3.21	1.42	47.3	71.3	50.0	61.2	59.6	49.6	51.8
F value		5.9**	9.62**	0.45NS	0.95NS	0.3NS	20.3**	22.3**	11.7**	9.7**	26.7**	16.1**

NOTES: 2 middle rows harvested with 1 sugar sample from each row. Powdery mildew ratings scored on a scale of 0 to 5 based on percentage of leaf surface covered with powdery mildew, where 0 = no symptoms observed to 5 = 100% of leaf area covered.

POWDERY MILDEW CONTROL, IMPERIAL VALLEY, CA, 2000-2001

Treatment	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH2-N ppm	Impur. Value
1. Eminent	10000	309	89.8	1132	351	2524	430	11625
2. Quadris	9807	306	89.2	1201	310	2510	506	12162
3. Procure	9749	309	89.8	1097	330	2420	449	11472
4. BAS 500 + Latron B-1956	10052	313	89.7	1153	321	2511	474	11906
5. Sulfur	10678	316	90.5	1134	330	2456	399	11087
6. Control	9235	304	88.9	1148	353	2597	518	12653
Mean	9919.8	309.4	89.6	1144.0	332.5	2502.9	462.8	11817.4
LSD (.05)	665.1	17.9	2.0	191.6	87.7	335.8	123.1	1853.0
C.V. (%)	5.6	4.8	1.9	13.9	21.9	11.1	22.1	13.0
F value	4.4**	0.5NS	0.6NS	0.3NS	0.3NS	0.3NS	1.2NS	0.8NS

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2001

Planted: June 11, 2001
Inoculated: July 11, 2001 with 1.31h/plant

168 entries x 3 reps, 2-row plots, 12 ft. long, sequential
24 entries x 3 reps, 1-row plots, 12 ft. long, sequential

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Hybrids					
US H11	11-3-99	3.0	5.3	5.3	3.5e
WS-PM9	4-18-95	3.0	4.7	5.0	3.5e
Beta 4776R	9-8-00	3.0	6.3	6.3	6.5
Beta 4430R	9-8-00	3.0	6.3	6.3	7.0
Monohikari	Seedex	2.7	7.3	8.3	7.5
Phoenix	2-5-01	3.0	6.7	8.0	8.0
HH142	9-7-00	3.0	6.0	7.0	6.5
HH141	3-5-01	3.0	6.0	7.0	6.5
Beta 6600	7-11-00	3.0	6.7	7.7	7.5e
E17	3-27-01	3.0	6.7	8.0	8.0e
WS-PM9	4-18-95	3.0	4.7	4.7	3.0e
US H11	11-3-99	2.7	5.3	5.0	3.5e
R078H2	C831-3HO x R978,(C78)	2.3	5.0	5.3	5.0e
R078H3	97-C562HO x R978	3.0	4.7	5.0	4.0
R078H5	C833-5(T-O)HO x R978	3.0	5.3	5.0	5.0
R078H7	C833-5aa x R978	3.0	5.0	5.3	4.5
R078H27	C831-4HO x R978	3.0	5.0	5.0	3.0e
R078H30	C829-3HO x R978	3.0	5.0	5.3	4.5e
R078H33	9833aa x R978	3.0	4.3	5.0	3.5e
R078H45	C867-1HO x R978	2.7	4.7	5.0	4.0e
R078H46	9869-6HO x R978	3.0	4.7	5.0	5.0e
R078H50(99)	99-C790-15CMS x R978	3.0	4.7	5.0	4.5e
R078H50	F92-C790-15CMS x R978	3.0	5.0	5.3	5.5
R078H35	9835T-Oaa x R978	3.0	5.0	5.3	5.0e
R078H56	9836HO x R978	3.0	5.7	6.3	7.0
R078H69	C869aa x R978	3.0	4.7	5.3	5.5
US H11	11-3-99	3.0	4.3	5.0	3.5e
Monohikari	Seedex	2.7	7.3	8.7	8.5
CR009-1H50	99-C790-15CMS x CR09-1	2.3	5.3	6.3	6.0e
CR011H50	92-C790-15CMS x CR11	3.0	5.7	6.3	6.5e
N030-5H50	C790-15CMS x RZM-NR N930-5	3.0	5.0	5.3	4.5
R076-89H50	C790-15CMS x RZM R976-89	3.0	5.0	5.7	6.0e
R076-89-5H50	92-C790-15CMS x C76-89-5	3.0	5.3	5.7	6.0e
Z025-9H50	99-C790-15CMS x CZ25-9	2.3	5.3	6.3	7.0
0927-29H50	99-C790-15CMS x 8927-29	2.7	6.0	6.3	7.0e
0929-112H50	99-C790-15CMS x 8929-112	2.7	6.0	6.0	6.5

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2001

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Hybrids (cont.)					
0929-114H50	99-C790-15CMS x 8929-114	3.0	5.7	5.7	6.5e
0930-19H50	99-C790-15CMS x 8930-19	3.0	5.3	5.3	5.5e
0931H50	92-C790-15CMS x RZM 9931	3.0	5.3	5.3	5.0e
0941H50	92-C790-15CMS x RZM 9941	3.0	5.7	6.0	6.0e
R076-89-18H5	C833-5(T-O)HO x RZM C76-89-18	3.0	5.0	5.3	6.0e
0931H5	C833-5(T-O)HO x RZM 9931	2.7	5.3	5.3	5.5e
US H11	11-3-99	2.7	4.7	5.0	3.5e
WS-PM9	4-18-95	2.3	4.3	5.0	3.5e
Multigerm, O.P. lines					
00-C37	Inc. U86-37, (C37)	2.3	4.3	5.0	5.0e
97-US22/3	Inc. Y009 (US22/3)	3.0	5.0	5.0	4.5e
00-US75	Inc. 97-US75	3.0	5.3	5.3	5.5e
97-SP22-O	Inc. SP7622-O	3.0	6.0	7.0	7.5
00-EL0204	RZM 99-EL0204	3.0	6.0	6.3	7.5e
99-C31/6	Inc. F86-31/6 (C31/6)	3.0	5.3	6.3	6.5e
99-C46/2	Inc. U86-46/2 (C46/2)	3.0	5.0	5.0	3.5e
R078(Iso)	Inc. C78	3.0	4.7	5.0	5.0e
R078(Sp)	Inc. C78	3.0	5.3	6.0	7.0
R078-3	Inc. R878-3	3.0	5.3	5.7	5.5e
R078-4	Inc. R878-4	3.0	5.0	5.3	4.5e
R078-8	Inc. R878-8	3.0	5.3	5.7	4.5e
R078-9	Inc. R878-9	3.0	5.0	5.3	5.0
R070-9	Inc. R870-9	3.0	4.7	5.3	5.0
R080-5	Inc. R880-5	3.0	4.7	6.0	6.5e
R080-9	Inc. R880-9	3.0	4.7	6.0	6.5
R080-13	Inc. R880-13	3.0	6.3	7.0	7.5
R080/2-9	Inc. R880/2-9	3.0	6.3	6.7	7.0
R080/2-11	Inc. R880/2-11	3.0	6.3	6.7	7.5
R080-45-10	Inc. R880-45-10	3.0	5.0	6.0	7.0
Y067	RZM Y967, (C67)	3.0	5.3	6.3	6.0
Y067-3	Inc. Y867-3	3.0	4.7	6.3	6.5
Y071	RZM Y971	3.0	5.3	6.0	6.5
Y072-4	Inc. Y872-4	3.0	5.7	6.0	6.5
Y075	RZM-% Y875(Sp)	3.0	5.7	6.0	6.5
Y090	Inc. FS progeny sel.	3.0	5.0	5.7	5.5e
Y068-1	Inc. Y868-1	3.0	5.7	6.7	6.5
Y068-2	Inc. Y868-2	3.0	5.0	5.7	5.0

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2001

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Multigerm, O.P. lines (cont.)					
Y068-4	Inc. Y868-4	3.0	5.0	5.7	6.5e
Y068-6	Inc. Y868-6	3.0	5.7	6.7	7.0
Y069-13	Inc. Y869-13	3.0	5.3	6.7	8.5
Y069-18	Inc. Y869-18	2.7	5.7	7.3	7.5
Y069-26	Inc. Y869-26	3.0	6.0	6.7	6.5
R078(Iso)	Inc. R978, (C78)	3.0	5.3	6.3	6.5
P007	PMR-RZM P907	3.0	5.7	6.3	6.5
P007/8	PMR-RZM P807-2; P808-7	3.0	5.7	6.7	6.5
P017	PMR-RZM P917-#(C), (CP01)	2.3	5.3	6.7	7.0
P018	PMR-RZM P918-#(C), (CP02)	3.0	5.7	6.0	6.0
P019	PMR-RZM P919-#(C)	2.7	6.3	7.0	6.5
P020	PMR-RZM P920-#(C)	2.3	6.0	6.0	6.5
00-C37	Inc. U86-C37, (C37)	3.0	5.3	6.0	6.0e
R076-89	RZM R976-89R	2.7	5.3	6.7	5.5e
R076-89-5	Inc. C76-89-5	3.0	5.3	6.3	6.0e
R076-89-5-9	Inc. R876-89-5NB-9	2.7	5.7	6.7	6.0
R039	Inc. R539, (C39R)	3.0	5.3	6.0	6.5
R036	RZM R936, (C79-8,R22)	3.0	5.3	5.7	4.5
R021	RZM R926,R927, (C26,C27)	3.0	5.3	5.7	6.0
US H11	11-3-99	3.0	5.3	6.0	6.5
Multigerm, S^f, A:aa populations and lines					
Monohikari	Seedex	3.0	7.3	7.3	8.5
0931	RZM 9931aa x A, (popn-931)	2.7	5.7	6.7	6.5
0931-5	Inc. 8931-5 (A,aa)	2.3	6.0	7.0	7.0
0931-7	Inc. 8931-7 (A,aa)	2.0	5.7	6.3	6.5
0941	RZM 9941aa x A	2.7	6.0	6.7	8.0e
0936	Inc. 8936 (A,aa)	3.0	6.3	6.3	7.0e
0935-25	Inc. 8935-25 (A,aa)	2.7	5.3	6.3	6.0
0936-8	Inc. 8936-8 (A,aa)	2.3	5.3	6.7	7.0
0936-10	Inc. 8936-10 (A,aa)	2.3	5.0	6.3	6.0e
0936-11	Inc. 8936-11 (A,aa)	2.7	5.3	6.3	6.5e
0936-16	Inc. 8936-16 (A,aa)	3.0	5.7	6.7	7.0
0942	RZM-% R576-89-18H18,19	3.0	5.0	6.0	6.0e
0934	RZM 9934 (A,aa)	3.0	5.0	6.3	6.0
0934-5	Inc. 8934-5 (A,aa)	3.0	5.0	6.3	7.0e
0921	RZM 9926aa x R926,R927	3.0	5.3	6.0	6.0e
0926	RZM-% 8926(Sp) (A,aa)	3.0	5.0	6.0	5.0

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
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(cont.)

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Multigerm, S^f, A:aa populations and lines (cont.)					
0747	Inc. 7747 (A,aa)	3.0	5.0	5.3	5.0e
Z025	RZM Z925aa x A, (CZ25)	3.0	6.0	6.3	7.0e
Z025-9	Z825-9aa x A, (CZ25-9)	3.0	5.7	6.7	7.0
0927-29	8927-29aa x A	2.7	6.3	7.3	7.5
0929-112	8929-112aa x A	3.0	5.7	6.3	6.0
0929-114	8929-114aa x A	2.3	5.3	5.7	5.5
0930-19	8930-19aa x A, (C930-19)	3.0	5.7	6.3	6.5
P012	PMR-RZM P912 (A,aa)	3.0	6.0	6.7	7.5
CR011	RZM CR910,11,12aa x A, (CR25)	2.7	6.3	7.0	8.0
CR009-1	RZM CR909-1aa x A, (CR09-1)	2.7	6.3	7.3	7.5e
N024	RZM N925,26,31,32(C),(A,aa)	2.7	6.3	7.3	7.0
9927-4	Inc. 7927-4VY, (C927-4)	2.7	6.7	7.3	7.5
9929-62	Inc. 7929-62, (C929-62)	2.7	6.7	7.0	7.5
9930-35	Inc. 7930-35, (C930-35)	2.3	5.0	6.0	6.0e
9929-4	Inc. 7929-4VY	2.0	6.0	7.0	7.5
9924-2	Inc. 7924-2	3.0	5.0	5.0	6.5
9933	8933aa x A, (Root aphid resist.)	3.0	5.0	6.0	6.0e
9932	RZM 8932aa x A, (CTR)	3.0	4.7	5.3	5.5e
9924	RZM 8924aa x A, (VYR)	2.7	5.7	6.3	6.5e
00-C37	Inc. U86-C37, (C37)	3.0	5.0	5.3	5.0e
Monogerm populations & lines					
00-FC123	RZM 99-FC123m	2.7	4.7	5.7	5.0
00-FC1014	RZM-% FC951014m	2.7	5.0	6.0	6.5e
N065M	RZM N965m(galls)M	3.0	5.0	5.7	6.0e
N065H5	C833-5(T-O)HO x RZM N965m	2.7	5.3	5.3	5.0e
00-790-15	Inc. F92-790-15, (C790-15)	2.3	5.7	6.3	5.5
00-790-15CMS	C790-68CMS x´C790-15	2.7	5.7	7.0	5.5
0833-5(Iso)	*RzRz*, T-0 8833-5(C),(A,aa)	2.3	5.0	5.7	6.0
0833-5(Sp)	RZM 9833-5(T-O),(C833-5)	3.0	5.0	5.7	6.0
0833-5HO(Sp)	RZM 9833-5(T-O) x C833-5T-O	3.0	5.0	5.3	5.0
0833-5H45	RZM C867-1HO x C833-5T-O	3.0	4.7	5.0	3.5
0833-5H50	C790-15CMS x C833-5T-O	3.0	5.3	5.0	5.0
0835M	RZM-% 8835 (A,aa)	3.0	5.3	5.3	5.0e
0835NBM	NB-% 8835 (A,aa)	3.0	5.0	5.0	6.0e
0835(Sp)	RZM 9833,9835mmaa x A	3.0	5.0	5.0	5.0e
0835H5	C833-5H0 x RZM 9835	3.0	5.0	5.0	4.0
0836	RZM 9836mmaa x A	3.0	5.3	5.3	6.5

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2001

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Monogerm populations & lines (cont.)					
0836H5	C833-5H0 x 9836	3.0	5.3	5.3	5.5
0836H7	C833-5aa x 9836	3.0	5.3	5.3	5.5
0838	RZM-% 8838 (A,aa)	3.0	5.3	5.3	6.0e
0840HO	RZM 9840HO x T-O,CTR,NB	3.0	5.3	5.3	5.5e
0840H5	C833-5HO x T-O,CTR,NB	3.0	4.7	5.0	5.0
0840H7	C833-5aa x T-O,CTR,NB	3.0	5.3	5.3	6.0
0840H35	9835T-Oaa x T-O,CTR,NB	3.0	5.0	6.0	6.0
0841H69	RZM 9869aa x T-O,CTR,NB	3.0	5.0	5.3	5.5e
0848M	RZM-% 8848,8810 (A,aa)	3.0	4.7	5.3	5.0
0911-4-10(Sp)	Inc. 9911-4-10(C)mm	2.3	5.0	6.3	5.0
0831-4-7	Inc. 9831-4-7	2.7	5.3	6.7	7.5e
0831-4-10	Inc. 9831-4-10	2.7	6.0	7.7	8.0
0834-2	Inc. 8834-2 (A,aa)	3.0	5.3	6.3	7.0
0836-1M	Inc. 8836-1 (A,aa)	2.7	6.0	7.0	7.0
0836-7	Inc. 8836-7 (A,aa)	3.0	5.3	6.7	6.5e
0837-6M	Inc. 8837-6 (A,aa)	3.0	5.3	6.3	6.0e
9867-1	RZM 7867-1m, (C867-1)	3.0	4.3	5.7	5.5
0562	Inc. 97-562, (C562)	3.0	4.3	5.0	4.5
0546	Inc. 97-546, (C546)	3.0	4.7	5.0	4.0
0718	Inc. 97-718, (C718)	3.0	4.3	5.0	5.0e
0762-17	Inc. 6762-17, (C762-17)	3.0	4.3	4.7	4.5
9840	840(C)mmaa x T-O,CTR,NB	3.0	5.3	5.7	6.0
0841	RZM 9840HO x T-O,CTR,NB	3.0	4.7	5.7	6.0
0841H32	RZM 9832aa x T-O,CTR,NB	3.0	5.0	5.3	5.5

24 entries x 3 reps, 1-row plots, 12 ft. long, sequential

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Full-sib progeny					
Y069 - 1	RZM Y969 PX	3.0	6.0	6.3	6.5
- 2	RZM Y969 PX	3.0	6.0	6.7	7.0
- 3	RZM Y969 PX	3.0	6.3	7.3	7.0
- 4	RZM Y969 PX	3.0	6.3	7.0	6.5
Y069 - 5	RZM Y969 PX	2.7	6.7	7.3	7.0
- 6	RZM Y969 PX	2.7	6.3	7.7	7.0
- 7	RZM Y969 PX	2.7	6.3	7.3	6.5
- 8	RZM Y969 PX	2.3	6.3	6.7	6.5
Y069 - 9	RZM Y969 PX	2.7	5.3	6.3	6.0
-10	RZM Y969 PX	2.3	5.3	6.0	6.0
-11	RZM Y969 PX	2.3	5.3	6.3	6.0
-12	RZM Y969 PX	2.7	5.3	6.3	5.0

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2001

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Rating 08/21	BSDF 2nd Rating 09/05	RTL Scores 08/28
Full-sib progeny (cont.)					
R078 - 1	RZM R978 PX	3.0	4.7	5.0	3.5e
- 2	RZM R978 PX	3.0	4.7	5.3	4.0
- 3	RZM R978 PX	2.7	5.0	5.0	3.5e
- 4	RZM R978 PX	3.0	5.0	5.3	4.0e
R080 - 1	RZM R980 PX	2.7	5.0	6.0	6.0
- 2	RZM R980 PX	3.0	5.7	6.3	6.0
- 3	RZM R980 PX	2.7	5.7	6.0	6.5
- 4	RZM R980 PX	3.0	5.3	6.0	5.5e
R080 - 5	RZM R980 PX	3.0	5.0	6.3	5.5e
- 6	RZM R980 PX	3.0	5.3	6.7	6.5e
- 7	RZM R980 PX	3.0	5.0	6.3	5.0
- 8	RZM R980 PX	3.0	5.3	6.0	5.5

NOTES: Scored on a scale of 0 to 9 where 9 = dead. Fair evaluation with variable plant growth and CTV infectin. BSDF scores based on all three replications. RTL scores from replication 1 and 2 only. Third replication was more variable. For RTL scores, e = individual plant escapes, late infection, or high resistance.

For stand counts, 0=no beets, 1=1-5 beets, 2=6-10 beets, and 3=over 10 beets.

TEST 4301. EVALUATION OF SELECTED PROGENY LINES FOR ERWINIA/POWDERY MILDEW, SALINAS, 2001

40 entries x 3 reps, sequential
1-row plots, 17.5 ft. long

Planted: April 11, 2001
Not harvested for yield

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/28	09/19	10/02	Mean	DI	%Healthy
Checks									
E740	Inc. E840 (Susc. ck.)	28.7	29.3	3.3	3.3	3.3	3.3	93.9	3.4
US H11	4-3-99	30.0	28.3	2.7	5.3	7.0	5.0	10.5	83.8
Inc. FS progeny from MM,S^sS^s lines									
R078-3	Inc. R878-3	30.0	29.7	2.0	3.7	3.3	3.0	33.7	58.5
R078-4	Inc. R878-4	28.3	28.7	0.0	0.7	0.0	0.2	31.7	59.6
R078-8	Inc. R878-8	28.7	28.7	0.0	0.7	1.3	0.7	18.1	78.0
R078-9	Inc. R878-9	29.0	29.7	0.0	1.3	0.7	0.7	23.8	69.7
R076-89	RZM R976-89R	26.3	26.3	0.0	0.0	0.0	0.0	20.5	70.7
R076-89-5	R876-89-5,NB	29.0	29.3	0.0	0.0	0.0	0.0	10.8	82.9
R076-89-5-9	R876-89-5NB-9	28.3	28.3	0.0	0.7	0.7	0.4	10.3	87.0
E740	Inc. E840 (Susc. ck.)	28.3	27.0	3.3	3.3	3.3	3.3	89.2	4.4
Y068-1	Inc. Y868-1	29.7	27.7	0.0	1.7	2.0	1.2	18.5	78.1
Y068-2	Inc. Y868-2	29.0	28.3	0.0	1.0	2.7	1.2	20.2	69.3
Y068-4	Inc. Y868-4	29.3	29.7	0.3	2.0	2.3	1.6	22.2	68.5
Y068-6	Inc. Y868-6	28.7	28.3	0.0	1.0	0.7	0.6	33.1	63.0
Y069-13	Inc. Y869-13	29.3	29.3	0.0	1.3	0.3	0.6	17.2	76.0
Y069-18	Inc. Y869-18	29.3	28.0	0.0	0.7	1.0	0.6	26.7	71.2
Y069-26	Inc. Y869-26	27.3	27.7	0.0	1.7	2.7	1.4	10.4	84.3
R070-9	Inc. R070-9	25.3	25.0	0.0	1.0	2.7	1.2	12.9	81.2
R080-5	Inc. R880-5	30.0	28.7	2.3	5.3	6.3	4.7	14.6	79.1
R080-9	Inc. R880-9	29.3	28.0	0.0	1.7	2.7	1.4	18.9	72.4
R080-13	Inc. R880-13	28.7	28.7	0.0	2.3	4.7	2.3	26.1	65.5
R080/2-9	Inc. R880/2-9	26.7	26.3	1.7	5.3	5.3	4.1	8.3	87.7

TEST 4301. EVALUATION OF SELECTED PROGENY LINES FOR ERWINIA/POWDERY MILDEW, SALINAS, 2001

(cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia	Root Rot
		No.	No.	08/28	09/19	10/02	Mean	DI	%Healthy
Inc. FS progeny from MM,S^sS^s lines (cont.)									
R080/2-11	Inc. R880/2-11	27.7	25.3	1.0	4.7	4.7	3.4	12.2	81.0
R080-45-10	Inc. R880-45-10	25.7	25.0	0.0	1.3	0.0	0.4	10.3	86.8
Y067-3	Inc. Y867-3	27.7	27.3	0.0	0.0	0.7	0.2	14.2	81.7
Y072-4	Inc. Y872-4	26.3	27.0	0.7	2.3	2.3	1.8	45.1	42.8
Inc. S_1 progeny lines									
0931- 5	Inc. 8913- 5 (A,aa)	29.0	26.3	0.0	1.0	1.0	0.7	6.7	89.9
0931- 7	Inc. 8931- 7 (A,aa)	27.3	25.0	0.0	0.0	0.0	0.0	14.1	74.9
0935-25	Inc. 8935-25 (A,aa)	28.7	27.0	0.0	0.0	0.0	0.0	4.7	92.0
0936- 8	Inc. 8936- 8 (A,aa)	27.3	28.0	0.0	0.0	0.0	0.0	3.1	92.8
0936-10	Inc. 8936-10 (A,aa)	28.7	27.3	0.0	0.0	0.0	0.0	26.8	62.7
0936-11	Inc. 8936-11 (A,aa)	30.3	29.7	0.3	0.0	0.0	0.1	17.6	74.1
0936-16	Inc. 8936-16 (A,aa)	28.7	28.7	0.0	0.0	0.0	0.0	15.6	81.3
0934- 5	Inc. 8934- 5 (A,aa)	29.3	29.3	1.7	3.3	3.7	2.9	26.1	62.4
Z025-9	Z825-9aa x A	28.7	28.0	0.3	0.0	0.0	0.1	42.5	52.8
0929-112	8929-112aa x A	28.3	26.7	0.0	0.0	0.0	0.0	5.6	93.7
0929-114	8929-114aa x A	27.0	25.0	0.0	0.0	0.0	0.0	50.7	42.6
0930-19	8930-19aa x A	27.7	28.7	0.0	0.0	0.0	0.0	11.7	81.0
0927-29	8927-29aa x A	27.7	28.3	0.0	0.0	0.7	0.2	5.0	89.5
CR009-1	CR909-1aa x A	30.0	48.0	1.0	2.7	1.0	1.6	29.7	62.8
Mean		28.4	28.3	0.5	1.5	1.7	1.2	22.8	71.0
LSD (.05)		3.5	9.0	1.4	2.4	2.5	1.8	13.8	17.1
C.V. (%)		7.6	19.5	169.8	98.7	93.3	89.0	37.2	14.8
F value		1.0NS	1.2NS	3.6**	3.9**	4.6**	5.2**	15.9**	10.9**

TEST 4401. EVALUATION OF BREEDING LINES AND POPULATIONS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

100 entries x 3 reps, sequential
1-row plots, 17.5 ft. long

Planted: April 11, 2001
Not harvested for yield

Variety	Description	Stand Count No.	Harv. Count No.	Powdery Mildew Score 08/28	09/19	10/02	Mean	Erwinia Root Rot DI	%Healthy
Checks									
US H11	new, 11-3-99	28.7	28.7	4.3	6.7	7.3	6.1	15.5	68.7
E740	Inc. E840 (Susc. ck)	27.3	25.7	3.0	3.0	3.0	3.0	95.9	1.4
Beta 4776R	Betaseed, 010228FH2, 9-8-00	30.3	32.3	2.3	3.7	4.7	3.6	57.8	34.1
HH142	Spreckels, 9-7-00	29.3	29.3	0.3	1.3	2.0	1.2	24.4	63.2
00-US75	Inc. 97-US75	28.0	27.3	2.0	5.0	6.0	4.3	50.5	36.6
00-C37	Inc. U86-37	30.0	29.3	3.0	5.3	5.7	4.7	31.4	60.6
97-US22/3	Inc. Y009 (US22/3)	29.3	28.0	2.0	3.3	5.7	3.7	46.3	40.5
97-SP22-0	Inc. SP7622-0	27.0	26.3	1.0	1.7	2.0	1.6	34.5	54.6
99-C46/2	Inc. U86-46/2	27.0	27.0	0.0	1.3	3.3	1.6	19.0	70.4
R978	RZM-ER-% R778,%	27.7	27.0	0.3	0.7	1.7	0.9	26.2	65.2
R078(Iso)	Inc. R978	29.3	30.0	0.0	0.0	1.0	0.3	27.8	66.9
R078(Sp)	Inc. R978	25.7	25.0	0.0	0.7	1.0	0.6	20.0	69.3
Multigerm, open-pollinated lines									
R980	RZM-ER-% R780/2,…	27.3	26.3	0.3	1.3	1.0	0.9	8.8	87.3
Y090	Inc. FS progeny selection	28.7	29.0	0.3	2.3	2.7	1.8	14.7	81.7
R039	Inc. R539, (C39R)	25.7	26.0	0.0	1.0	0.3	0.4	17.4	81.3
99-C31/6	Inc. F86-31/6	28.0	28.3	0.7	0.0	0.3	0.3	28.8	64.6
Y969(Iso)	RZM-ER-% Y769, (C69)	28.3	27.7	0.0	1.7	3.7	1.8	10.4	84.2
Y967	RZM-ER-% Y767	28.7	28.3	0.0	0.7	1.3	0.7	13.1	81.2
Y067	RZM Y967	29.7	30.7	0.0	0.7	1.0	0.6	12.2	79.6
Y971	RZM-ER-% Y771	30.3	30.0	0.3	3.7	3.0	2.3	29.2	59.3
Y975	RZM Y875	28.3	27.3	1.0	3.7	3.3	2.7	22.0	69.7
Y075	RZM-%S Y875 (Sp)	26.7	25.7	0.3	2.3	3.7	2.1	18.2	76.0
R036	RZM R936	25.7	25.0	2.7	5.0	5.3	4.3	29.8	58.1
R021	RZM R926,R927,(C26,C27)	28.3	29.3	2.0	3.3	3.7	3.0	29.9	65.5

TEST 4401. EVALUATION OF BREEDING LINES AND POPULATIONS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

(cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/28	09/19	10/02	Mean	DI	%Healthy
Multigerm, open-pollinated lines (cont.)									
Y071	RZM Y971	28.7	28.0	0.3	2.3	3.0	1.9	15.9	76.3
P007/8	PMR-RZM P807-2; P808-7	28.3	29.3	0.0	0.7	0.0	0.2	25.0	71.2
P017	PMR-RZM P917-#(C)	28.3	29.3	1.0	2.3	4.3	2.6	12.8	79.4
P018	PMR-RZM P918-#(C)	28.3	27.3	0.3	1.7	2.7	1.6	28.1	62.7
P019	PMR-RZM P919-#(C)	26.0	25.0	0.0	0.0	0.7	0.2	35.7	58.3
P020	PMR-RZM P920-#(C)	29.0	30.0	0.0	2.0	2.7	1.6	7.5	92.0
P007	PMR-RZM P907	29.3	31.3	0.3	0.0	1.0	0.4	29.6	62.8
00-EL0204	RZM 99-EL-02,04	28.0	29.0	0.0	2.7	5.3	2.7	15.6	79.4
Multigerm,S^f,Aa populations & lines									
9931	RZM 8931aa x A	29.0	30.3	0.0	0.7	1.3	0.7	11.6	85.6
0931	RZM 9931aa x A	30.0	30.3	0.0	1.7	2.0	1.2	14.0	81.8
9933	8933aa x A	29.0	30.0	0.7	2.0	2.7	1.8	21.0	71.1
9941	941(C)aa x A	29.3	29.0	0.0	0.7	0.7	0.4	14.4	79.1
0941	RZM 9941aa x A	29.3	29.3	0.3	2.0	3.7	2.0	14.3	77.1
Z025	RZM Z925aa x A	28.7	29.0	2.3	4.0	5.0	3.8	15.5	74.0
E740	Inc. E840	29.0	30.7	4.7	5.3	5.7	5.2	85.3	10.4
0926	RZM-%S 8926 (A,aa)	27.7	28.3	0.0	2.3	2.7	1.7	15.6	74.1
0921	RZM 9926aa x R926,7	29.3	29.0	0.0	3.0	3.0	2.0	22.7	65.5
CR911(Sp)	CR811(C)aa x A(C)	28.7	29.0	2.0	3.3	5.0	3.4	18.3	71.3
CR011	RZM CR910,11,12(C)aa x A	28.7	29.7	2.0	3.0	2.7	2.6	13.7	79.7
CR009-1	RZM CR909-1aa x A	30.3	30.7	0.7	0.7	0.7	0.7	44.1	50.5
0934	RZM 9934 (A,aa)	29.3	28.7	0.7	1.0	1.3	1.0	17.2	74.4
P012	PMR-RZM P912 (A,aa)	27.7	25.7	0.3	1.0	2.3	1.2	12.0	76.8
0747	Inc. 7747 (A,aa)	28.0	28.7	3.3	5.7	7.3	5.4	8.8	81.3
0936	Inc. 8936 (A,aa)	28.7	28.0	0.0	0.7	1.3	0.7	12.3	80.1
0942	RZM-%S R576-89-18H18,19 (Aa)	28.0	27.0	0.0	0.0	0.7	0.2	8.8	86.0
N024	RZM N925,6; N931,2 (A,aa)	28.0	26.3	0.0	1.7	0.7	0.8	26.6	63.3
N065M	RZM N965m (galls)	29.3	29.7	2.0	2.3	4.0	2.8	18.2	74.1
E740	Inc. E840	27.0	27.7	2.7	2.3	3.0	2.7	83.4	12.8

TEST 4401. EVALUATION OF BREEDING LINES AND POPULATIONS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

(cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/28	09/19	10/02	Mean	DI	%Healthy
Monogerm, S^f, Aa populations & lines									
US H11	11-3-99	30.0	30.0	2.0	5.7	7.3	5.0	14.3	80.1
0835(Sp)	RZM 9833,5aa x A	28.0	29.3	1.3	4.3	3.7	3.1	45.4	45.7
0835HO	9835(T-O)HO x " "	28.7	28.0	0.3	1.7	1.3	1.1	53.3	41.5
0835H5	9833-5(T-O)HO x " "	29.7	30.0	0.3	3.0	2.7	2.0	35.1	54.1
0835(Iso)mm	RZM-% 8835(A,aa)mm	29.3	28.3	0.3	3.3	3.3	2.3	27.3	67.0
0838mm	RZM-% 8838(A,aa)mm	29.7	29.7	1.0	4.0	5.0	3.3	30.5	63.0
0848M	RZM-% 8848,8810 (A,aa)	29.0	30.0	0.3	2.0	1.3	1.2	43.8	47.5
0835NBM	NB-%S 8835 (A,aa)	31.3	31.3	4.3	6.0	6.0	5.4	44.4	46.7
0836	RZM 9836mmaa x A	28.0	28.7	3.3	4.3	4.7	4.1	12.2	75.9
0836H5	9833-5(T-O)HO x " "	30.7	30.3	3.3	4.0	5.7	4.3	23.9	69.4
0836H7	8833-5aa x " "	28.3	29.0	2.7	4.7	5.3	4.2	9.0	82.1
0841H5	9833-5(T-O)HO x 841(C)	29.3	28.7	1.3	2.0	2.0	1.8	26.6	68.4
0841H7	9833-5aa x 841(C)	30.3	29.3	0.0	0.0	0.7	0.2	45.5	43.1
0841H35	9835T-Oaa x 841(C)	29.7	28.7	1.3	2.7	3.0	2.3	42.9	47.1
0841H69	RZM 9869aa x 841(C)	27.7	27.0	2.3	4.7	5.3	4.1	58.0	28.9
0562	Inc. 97-562 (C562)	29.0	23.3	0.0	0.0	0.7	0.2	9.5	85.3
0546	Inc. 97-546 (C546)	27.0	20.7	0.0	0.7	1.7	0.8	11.4	80.8
0718	Inc. 97-718 (C718)	27.7	19.7	0.0	0.7	0.3	0.3	35.7	61.5
0762-17	Inc. 6762-17 (C762-17)	29.7	25.7	0.0	0.0	0.0	0.0	42.3	52.1
00-FC1041m	RZM-%S FC951014mm	29.0	28.7	0.3	1.7	3.0	1.7	42.2	50.8
00-FC123	RZM 99-FC1-2,-2mm	28.7	28.3	0.7	2.3	1.3	1.4	35.5	51.5
0833-5(Iso)	RzRz,T-O,8833-5(C)	29.0	28.7	0.0	2.3	2.7	1.7	21.7	71.2
0833-5(Sp)	RZM 9833-5(T-O)mmaa x A	29.3	27.7	0.0	1.0	0.7	0.6	26.0	62.1
0833-5H0(Sp)	RZM 9833-5(T-O)HO x " "	30.3	31.3	0.7	1.3	1.7	1.2	29.2	56.3

TEST 4401. EVALUATION OF BREEDING LINES AND POPULATIONS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

(cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/28	09/19	10/02	Mean	DI	%Healthy
Monogerm,S^f,Aa populations & lines (cont.)									
0833-5H50	C790-15CMS x " "	30.7	30.7	0.0	1.3	0.7	0.7	48.2	42.9
E740	Inc. E840	29.3	30.7	2.0	2.3	2.0	2.1	90.7	3.3
US H11	11-3-99	30.7	29.3	1.3	4.7	6.0	4.0	22.2	67.0
0833-5H45	RZM 9867-1HO x " "	29.3	30.0	0.0	1.7	2.0	1.2	38.8	54.5
0833-5H46	RZM 9869-6HO x " "	31.0	32.7	1.0	4.0	5.7	3.6	17.0	69.0
00-790-15	Inc. F92-790-15, (C790-15)	29.3	27.7	0.0	0.0	0.0	0.0	20.0	66.2
00-790-15CMS	U88-790-68CMS x " "	30.0	30.0	0.3	0.0	0.0	0.1	45.3	46.7
0911-4-10(Iso)	RZM 9911-4-10-#(C)mm	29.0	28.7	0.0	0.0	0.0	0.0	5.6	89.3
0911-4-10H50(Iso)	C790-15CMS x " "	30.3	29.7	0.0	1.3	0.7	0.7	27.9	60.8
0911-4-10(Sp)	Inc. 9911-4-10(C)mm	28.0	27.7	0.0	0.0	0.0	0.0	3.4	92.7
0911-4-10H50	C790-15CMS x " "	30.3	30.7	0.0	0.7	0.7	0.4	31.0	66.1
0911-4-10H5	9833-5HO x " "	28.7	29.3	0.0	2.3	3.0	1.8	10.2	82.5
0911-4-10H7	9833-5aa x 9911-4-10m	23.0	25.0	2.0	3.0	4.7	3.2	28.6	55.2
E740	Inc. E840	24.7	28.0	2.7	2.7	3.0	2.8	72.8	19.4
0831-4-10	Inc. 9831-4-10	30.3	29.3	1.3	4.7	3.7	3.2	62.6	22.6
0831-4-7	Inc. 9831-4-7	28.3	27.7	0.7	4.0	4.7	3.1	26.5	59.5
N030-5NN	RZM-NR N930-5 (galls)	20.3	21.0	0.3	0.0	0.0	0.1	27.6	60.3
N030-5NNH50	C790-15CMS x " "	30.7	29.0	1.0	3.0	2.0	2.0	27.8	63.1
0834-2	Inc. 8834-2(A,aa)mm	30.0	29.0	1.0	2.3	1.3	1.6	76.8	19.2
0836-1M	Inc. 8836-1(A,aa)M	26.3	26.3	0.3	2.7	4.0	2.3	9.3	87.7
0836-7	Inc. 8836-7(A,aa)mm	30.7	30.3	0.0	1.0	0.3	0.4	7.2	88.8
0837-6M	Inc. 8837-6(A,aa)M	30.0	28.3	0.0	1.0	2.3	1.1	22.0	69.5
0808-9H5	9833-5(T-O)HO x 8809-9	30.7	29.7	0.0	0.0	1.0	0.3	22.0	73.0
0808-15H5	9833-5(T-O)HO x 8808-15	31.7	31.7	0.0	1.3	1.3	0.9	33.1	56.9
Mean		28.7	28.4	0.9	2.2	2.7	1.9	28.7	63.2
LSD (.05)		3.1	4.2	1.6	2.5	2.6	1.9	14.4	17.2
C.V. (%)		6.8	9.2	108.6	71.4	60.1	61.6	31.2	16.9
F value		2.2**	2.2**	4.2**	3.4**	4.4**	4.8**	13.9**	10.1**

TEST 4501. EVALUATION OF HYBRIDS WITH SELECTED PROGENY LINES FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

40 entries x 3 reps, sequential
1-row plots, 17.5 ft. long

Planted: April 11, 2001
Not harvested for yield

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/31	09/19	10/02	Mean	DI	%Healthy
Checks									
E740	Inc. E840 (Susc. ck.)	28.3	28.7	5.7	5.7	5.7	5.7	85.3	8.1
US H11	new, 9-3-99	31.0	31.0	5.7	7.3	8.0	7.0	16.1	76.6
Hybrids with FS progeny lines									
R078-3H50	C790-15CMS x R878-3	28.0	29.7	2.3	4.3	4.0	3.6	39.0	50.6
R078-4H50	C790-15CMS x R878-4	29.3	30.7	1.3	0.7	0.0	0.7	23.5	67.8
R078-8H50	C790-15CMS x R878-8	28.7	28.0	0.7	0.7	0.3	0.6	18.9	73.8
R078-9H50	C790-15CMS x R878-9	28.7	27.3	0.7	1.7	0.3	0.9	27.3	63.4
R076-89H50	C790-15CMS x RZM R976-89R	31.0	29.0	1.3	2.3	2.3	2.0	37.8	53.0
R076-89-5H50	C790-15CMS x R876-89-5,NB	30.3	29.3	0.0	1.3	0.7	0.7	19.9	74.9
R076-89-5-9H50	C790-15CMS x R876-89-5NB-9	29.7	29.3	1.0	1.3	0.0	0.8	23.7	68.0
R076-89-18H5	9833-5(T-O)HO x RZM R976-89-18	28.7	28.0	0.3	1.7	2.0	1.3	21.7	71.7
Y068-1H50	C790-15CMS x Y868-1	29.0	28.3	3.0	5.0	5.3	4.4	17.8	77.7
Y068-2H50	C790-15CMS x Y868-2	28.0	29.3	1.0	4.0	4.7	3.2	18.2	76.2
Y068-4H50	C790-15CMS x Y868-4	28.7	28.7	2.7	4.0	5.0	3.9	27.7	70.5
Y068-6H50	C790-15CMS x Y868-6	29.3	29.7	2.3	2.0	1.7	2.0	28.0	67.4
Y069-13H50	C790-15CMS x Y868-13	28.3	27.3	0.3	2.3	1.0	1.2	33.9	58.3
Y069-18H50	C790-15CMS x Y869-18	29.0	28.7	0.0	0.0	1.0	0.3	26.0	66.8
Y069-26H50	C790-15CMS x Y869-26	28.3	29.0	2.0	2.7	2.0	2.2	30.3	64.1
R070-9H50	C790-15CMS x R870-9	28.0	28.0	1.0	1.3	0.0	0.8	20.0	71.1
R080-5H50	C790-15CMS x R880-5	29.7	30.7	3.3	5.0	6.3	4.9	14.6	77.7
R080-9H50	C790-15CMS x R880-9	29.0	28.3	0.7	1.3	1.7	1.2	23.9	68.4

TEST 4501. EVALUATION OF HYBRIDS WITH SELECTED PROGENY LINES FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

(cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/31	09/19	10/02	Mean	DI	%Healthy
Hybrids with FS progeny lines (cont.)									
R080-13H50	C790-15CMS x R880-13	27.7	26.3	1.7	3.7	3.0	2.8	30.5	57.8
R080/2-9H50	C790-15CMS x R880/2-9	29.0	28.3	2.0	3.0	3.3	2.8	10.0	84.7
R080/2-11H50	C790-15CMS x R880/2-11	29.0	29.3	1.3	2.7	2.7	2.2	23.9	69.5
R080-45-10H50	C790-15CMS x R880-45-10	30.7	31.0	0.0	1.7	0.7	0.8	19.1	75.9
Y067-3H50	C790-15CMS x Y867-3	28.0	29.0	0.3	1.7	1.3	1.1	12.2	83.7
Y072-4H50	C790-15CMS x Y872-4	29.0	29.3	2.3	2.0	2.3	2.2	28.8	64.7
Hybrids with S_1 progeny lines									
0931-5H50	C790-15CMS x 8931-5	27.3	25.7	1.0	3.0	1.7	1.9	9.6	77.1
0931-7H50	C790-15CMS x 8931-7	28.3	28.0	0.3	0.0	0.0	0.1	24.5	67.7
0935-25H50	C790-15CMS x 8935-25	26.7	27.3	0.7	3.0	2.3	2.0	21.1	73.9
0936-8H50	C790-15CMS x 8936-8	26.3	27.3	0.0	0.7	0.0	0.2	17.1	78.0
0936-10H50	C790-15CMS x 8936-10	31.0	31.0	0.0	0.0	0.0	0.0	22.0	69.8
0936-11H50	C790-15CMS x 8936-11	30.0	29.7	0.0	0.0	0.0	0.0	21.9	73.0
0936-16H50	C790-15CMS x 8936-16	27.7	27.3	0.0	0.0	0.0	0.0	18.8	73.1
0934-5H50	C790-15CMS x 8934-5	25.7	25.0	1.0	3.0	3.7	2.6	30.8	60.8
Z025-9H50	C790-15CMS x Z825-9	28.0	27.0	0.3	0.0	0.0	0.1	39.3	52.4
0929-112H50	C790-15CMS x 8929-112	30.3	30.3	2.3	4.0	2.7	3.0	13.2	82.9
0929-114H50	C790-15CMS x 8929-114	30.0	29.3	1.0	1.0	0.7	0.9	38.0	56.1
0930-19H50	C790-15CMS x 8930-19	29.7	30.7	0.0	0.0	0.0	0.0	25.9	65.9
0927-29H50	C790-15CMS x 8927-29	30.3	30.3	0.0	0.0	0.7	0.2	13.4	79.6
CR009-1H50	C790-15CMS x CR909-1	28.3	28.3	0.3	1.3	2.0	1.2	34.5	60.9
Mean		28.9	28.7	1.3	2.1	2.0	1.8	25.2	67.8
LSD (.05)		3.7	4.1	1.7	2.1	2.3	1.5	12.7	15.4
C.V. (%)		7.8	8.8	82.1	61.2	70.3	52.6	31.1	14.0
F value		0.9NS	1.0NS	5.5**	5.7**	6.5**	9.5**	7.7**	5.6**

TEST 4601. EVALUATION OF EXPERIMENTAL HYBRIDS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

80 entries x 3 reps, sequential
1-row plots, 17.5 ft. long

Planted: April 11, 2001
Not harvested for yield
Inoc. Ecb: July 13, 2001

Variety	Description	Stand Count No.	Harv. Count No.	Powdery Mildew Score 08/31	09/19	10/02	Mean	Erwinia Root Rot DI	%Healthy
Checks									
Beta 4776R	Betaseed, 010228FH2, 9-8-00	28.7	28.0	2.0	4.0	4.7	3.6	21.5	77.3
Beta 4430R	Betaseed, 010269FH2, 9-8-00	30.0	29.7	0.3	0.0	1.3	0.6	37.1	60.8
HH142	Spreckels, 9-7-00	26.0	25.0	0.0	0.0	0.7	0.2	19.5	72.8
Beta 6600	Betaseed, L9N490018AA, 7-11-00	29.0	27.7	1.3	4.0	5.0	3.4	28.8	64.3
Monohikari	Seedex, L7383, 3-1-00	30.3	27.7	2.0	5.7	7.3	5.0	22.9	73.1
Crystal 205	L0205C8602, 3-1-00	28.7	29.0	0.3	4.7	6.0	3.7	15.5	82.6
Phoenix	Spreckels, 3-2-00	29.3	31.0	0.7	0.0	1.0	0.6	66.2	31.2
Alpine	Spreckels, 3-2-00	29.3	28.0	1.3	3.3	3.0	2.6	20.1	73.1
E17	Michigan Hybrid, 3/01	28.3	27.3	1.7	3.3	6.0	3.7	42.3	48.2
HH141	Spreckels, 2-5-01	28.7	30.7	1.3	2.7	4.0	2.7	49.1	46.4
US H11	11-3-99 (Ecb resistant check)	30.3	30.7	5.0	7.0	8.0	6.7	15.9	73.4
E740	Inc. E840 (Ecb susceptible ck)	29.0	29.7	5.3	5.3	5.7	5.4	83.9	10.8
Hybrids with C833-5									
R078H5	9833-5(T-O)HO x R978,(C78)	29.0	28.3	1.7	3.0	2.7	2.4	14.1	77.8
R078H7	9833-5aa x R978	29.3	29.0	1.3	2.0	3.3	2.2	10.1	84.8
0941H5	9833-5(T-O)HO x RZM 9941	28.3	29.7	0.7	1.7	3.0	1.8	11.2	81.1
0931H5	9833-5(T-O)HO x RZM 9931	30.0	29.3	0.0	1.0	2.0	1.0	15.5	80.8
Z025H5	9833-5(T-O)HO x RZM Z925	28.7	28.0	1.0	2.7	3.0	2.2	11.7	82.2
CR011H5	9833-5(T-O)HO x RZM CR910,11,12	29.3	30.3	2.0	1.3	2.0	1.8	14.8	78.3
0927-29H5	9833-5(T-O) x 8927-29	27.0	27.3	0.7	0.7	0.3	0.6	6.6	82.8
0929-112H5	9833-5HO x 8929-112	28.3	27.3	0.3	0.7	1.0	0.7	9.3	86.4
0929-114H5	9833-5HO x 8929-114	29.7	29.0	0.0	2.3	2.7	1.7	23.7	71.1
0930-9H5	9833-5HO x 8930-19,(C930-19)	28.7	27.3	0.0	0.7	0.7	0.4	14.9	81.2
Z025-9H5	9833-5HO x Z825-9,(CZ25-9)	28.0	28.0	0.0	0.0	0.3	0.1	22.5	73.6
CR009-1H5	9833-5HO x CR909-1,(CR09-1)	30.7	30.0	0.7	0.7	0.7	0.7	21.9	73.1

TEST 4601. EVALUATION OF EXPERIMENTAL HYBRIDS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

(cont.)

Variety	Description	Stand Count No.	Harv. Count No.	Powdery Mildew Score 08/31	09/19	10/02	Mean	Erwinia Root Rot DI	%Healthy
Hybrids with C833-5 (cont.)									
0911-4-10H5	9833-5HO x 9911-4-10	30.3	29.0	1.3	1.3	2.0	1.6	12.5	75.7
R021H5	9833-5(T-O)HO x R926,7,(C26,C27)	29.3	29.3	2.3	3.3	3.3	3.0	25.8	71.8
N065H5	9833-5(T-O)HO x RZM N965(g)	28.0	27.7	2.0	2.7	3.0	2.6	24.5	70.7
E740	Inc. E840,(susc.ck.)	28.3	28.3	4.0	4.0	4.0	4.0	85.7	9.3
Experimental hybrids with C78 pollinator									
R078H50	F92-C790-15CMS x R978	30.0	30.7	1.3	2.0	2.3	1.9	22.2	75.7
R078H50(99)	99-C790-15CMS x R978	28.0	28.0	0.7	0.7	1.3	0.9	17.8	77.3
R078H5	C833-5(T-O)HO x R978	27.3	28.0	0.7	1.3	1.7	1.2	20.5	71.7
R078H3	97-C562HO x R978	28.7	29.3	1.0	0.7	2.7	1.4	21.8	72.6
R078H37	4807HO (C306/2HO) x R978	27.7	27.7	0.7	2.3	2.3	1.8	29.6	59.4
R078H2	C831-3HO x R978	28.0	29.0	0.7	1.7	3.0	1.8	29.0	69.3
R078H27	C831-4HO x R978	30.3	30.0	1.7	1.7	3.3	2.2	33.0	55.6
R078H46	9869-5HO x R978	29.3	29.0	2.7	5.7	7.0	5.1	9.5	89.7
R078H45	C867-1HO x R978	27.7	27.7	0.7	0.7	2.3	1.2	10.9	82.1
R078H30	C829-3HO x R978	28.0	28.3	2.7	4.0	4.7	3.8	24.5	72.8
R078H13	C833-12HO x R978	27.0	25.7	1.7	3.3	4.0	3.0	29.0	62.3
R078H70	RZM 9869HO x R978	28.7	29.0	1.0	3.3	5.0	3.1	19.8	75.7
R078H55	9833(T-O)H5O x R978	28.3	28.0	0.3	0.7	3.0	1.3	28.2	69.1
R078H35	9835(T-O)aa x R978	28.7	27.0	1.3	2.7	4.0	2.7	20.5	75.4
R078H33	C833aa x R978	28.7	28.3	2.3	4.0	6.7	4.3	23.3	70.2
R078H7(MR)	RZM 9833-5aa x R978	27.3	26.3	1.3	2.0	1.7	1.7	8.4	87.2
R078H69	C869aa x R978	30.0	28.3	0.3	4.0	4.7	3.0	15.2	84.1
R078H19	RZM 9818maa x R978	29.0	29.0	0.0	2.3	2.0	1.4	11.2	86.3
Experimental hybrids with popn-941 pollinator									
E740	Inc. E840,(susc.ck.)	29.0	27.3	3.3	6.7	5.7	5.2	74.1	21.0
0941H5	C833-5(T-O)HO x RZM 9941	29.0	27.0	2.3	2.3	2.3	2.3	19.4	76.7

TEST 4601. EVALUATION OF EXPERIMENTAL HYBRIDS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001

(cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/31	09/19	10/02	Mean	DI	%Healthy
Experimental hybrids with popn-941 pollinator (cont.)									
0941H2	C831-3HO x RZM 9941	29.0	27.7	0.7	0.7	0.0	0.4	23.9	68.8
0941H27	C831-4HO x RZM 9941	28.7	27.0	1.0	3.3	4.3	2.9	16.9	75.0
0941H45	C867-1HO x RZM 9941	29.3	30.7	0.0	0.0	0.0	0.0	11.1	83.7
0941H46	9869-6HO x RZM 9941	30.0	29.0	1.7	4.0	5.3	3.7	9.2	83.7
0941H37	4807(C306/2CMS) x RZM 9941	29.0	30.3	0.3	2.3	2.0	1.6	20.2	73.2
0941H55	9835(T-O)HO x RZM 9941	27.7	28.0	0.0	1.3	1.3	0.9	12.2	84.4
0941H56	9836HO x RZM 9941	28.3	25.7	2.3	4.0	4.7	3.7	4.6	91.5
0941H70	C869HO x RZM 9941	28.3	29.7	1.3	1.0	4.0	2.1	16.4	74.8
Hybrids with C790-15CMS									
US H11	11-3-99 (resist.ck.)	28.7	25.0	4.7	4.7	8.0	5.8	19.6	69.9
E740	Inc. E840 (susc.ck.)	27.0	27.0	4.0	4.0	4.0	4.0	81.5	10.6
0931H50	F92-790-15CMS x RZM 9931	30.3	31.0	1.3	2.3	1.3	1.7	19.3	74.0
Z025H50	F92-790-15CMS x RZM Z925	29.7	29.7	0.3	0.7	1.0	0.7	31.1	59.5
CR011H50	F92-790-15CMS x RZM CR910,11,12	31.0	32.7	1.0	1.7	1.3	1.3	32.4	65.0
0911-4-10H50	99-790-15CMS x 9911-4-10m	30.3	30.0	0.3	0.7	0.7	0.6	22.3	64.4
R021H50	99-790-15CMS x RZM R926,7	29.0	26.3	1.3	2.7	2.7	2.2	34.2	56.0
Y075H50	C790-15CMS x RZM-%S Y875	30.0	30.7	0.0	0.0	0.7	0.2	17.1	75.6
0926H50	C790-15CMS x RZM-%S 8926	28.0	27.7	0.0	0.0	0.7	0.2	22.9	71.9
0942H50	C790-15CMS x RZM-% R576-89-18H18,19	29.0	26.3	0.0	0.7	0.7	0.4	22.6	69.9
P007/8H50	C790-15CMS x PMR-RZM P807,8	28.3	28.7	0.3	0.7	0.7	0.6	20.4	72.3
E740	Inc. E840 (susc. ck.)	28.3	30.0	5.0	4.3	4.0	4.4	78.3	15.3
US H11	11-3-99 (resist.ck.)	30.0	29.3	4.3	6.7	8.3	6.4	17.7	74.3
0936H50	C790-15CMS x 8936	29.3	29.7	0.7	0.7	1.7	1.0	21.6	72.8
Y067H50	C790-15CMS x RZM Y967	31.0	32.0	0.0	0.0	0.0	0.0	25.1	68.5
R036H50	C790-15CMS x RZM R936	30.0	30.7	1.0	1.7	2.3	1.7	32.8	63.4

TEST 4601. EVALUATION OF EXPERIMENTAL HYBRIDS FOR ERWINIA/POWDERY MILDEW, SALINAS, CA, 2001 (cont.)

Variety	Description	Stand Count	Harv. Count	Powdery Mildew Score				Erwinia Root Rot	
		No.	No.	08/31	09/19	10/02	Mean	DI	%Healthy
Hybrids with C790-15CMS (cont.)									
0747H50	C790-15CMS x 7747	29.7	26.7	1.3	3.7	5.0	3.3	18.4	72.1
P019H50	C790-15CMS x PMR-RZM P919-#(C)	29.7	30.3	0.7	2.0	2.3	1.7	29.1	63.7
P020H50	C790-15CMS x PMR-RZM P920-#(C)	31.0	32.7	0.7	1.0	1.7	1.1	12.7	82.2
P007H50	C790-15CMS x PMR-RZM P907	30.7	32.0	0.7	1.0	2.0	1.2	33.1	60.6
P012H50	C790-15CMS x PMR-RZM P912	29.7	29.3	0.7	1.3	1.7	1.2	11.5	84.7
0934H50	C790-15CMS x RZM 9934	28.3	27.7	1.7	2.3	3.0	2.3	14.7	78.0
Y071H50	C790-15CMS x RZM Y971	28.3	30.0	1.7	1.0	1.0	1.2	17.1	81.4
E740	Inc. E840 (susc.ck.)	28.7	28.0	5.7	5.7	5.7	5.7	86.3	8.4
Mean		29.0	28.7	1.4	2.3	3.0	2.2	25.7	68.5
LSD (.05)		3.2	4.4	2.2	2.5	2.4	2.1	13.8	17.5
C.V. (%)		6.8	9.4	98.8	67.9	50.3	56.9	33.5	15.9
F value		0.8NS	1.1NS	3.0**	3.8**	5.7**	4.9**	14.3**	9.1**

NOTES: Inoculated with *Erwinia* on July 13, 2001. Scored for Erwinia rot October 31, 2001. Scored on a scale of 0 to 100% rot. DI = average %rot per root. % healthy = roots with less than 8% rot divided by total. E740 = C40 = susceptible check. US H11 = resistant check for Erwinia and susceptible check for powdery mildew.

Test was also infected with rhizomania which affected growth of rhizomania susceptible plants.

Powdery mildew was not controlled but development was slow, mild and variable. Powdery mildew scored on a scale of 0 to 9 where 9 = 100% of mature leaf area covered with mildew.

TEST 4201-1. CODED POWDERY MILDEW TEST, SALINAS, CA, 2001

43 entries x 6 reps, sequential
1-row plots, 11 ft. long

Planted: April 11, 2001
Not harvested for yield

Code No.	Variety	Company	Stand Count No.	Powdery Mildew Score 8/24	8/28	9/06	9/13	9/19	9/25	10/2	Mean
CBGA entries											
PM- 1	7CG7410	Betaseed	16.5	0.5	0.8	2.8	3.2	5.0	6.0	7.5	3.7
- 2	Crystal 9922	Crystal	16.7	0.3	0.2	3.2	3.0	5.0	5.7	5.8	3.3
- 3	8CG7168	Betaseed	17.2	3.5	4.3	5.3	5.7	7.3	8.3	8.8	6.2
- 4	HH-142	Spreckels	16.3	1.5	1.5	3.7	2.5	4.8	5.8	6.8	3.8
- 5	SS-NB7R	Spreckels	17.3	3.8	3.7	5.5	4.3	6.5	7.5	8.0	5.6
- 6	4KJ0164	Betaseed	16.3	3.7	4.2	5.8	5.5	7.2	8.7	9.0	6.3
- 7	Crystal 9923	Crystal	17.3	3.7	4.5	5.5	5.3	6.7	8.2	8.5	6.0
- 8	Crystal 0025	Crystal	16.3	3.3	4.2	5.7	5.3	6.5	8.0	8.2	5.9
- 9	7KJ0146	Betaseed	17.5	0.7	1.7	3.3	4.2	5.3	6.8	6.8	4.1
-10	8CG7167	Betaseed	16.8	5.3	6.2	6.5	6.7	8.2	8.8	8.7	7.2
-11	99HX975	Spreckels	15.3	4.5	5.3	5.8	6.8	8.2	9.0	9.0	7.0
-12	Beta 4175R	Betaseed	18.5	5.0	5.7	6.7	6.7	8.7	8.8	9.0	7.2
-13	HH-141	Spreckels	17.0	3.3	4.2	5.5	5.5	7.8	8.2	8.2	6.1
-14	00HX001	Spreckels	18.5	2.2	2.3	4.5	3.7	6.0	6.7	7.3	4.7
-15	Beta 4430R	Betaseed	17.5	2.3	2.3	4.5	4.3	5.7	7.0	7.8	4.9
-16	99HX976	Spreckels	16.0	3.8	4.0	5.0	4.8	6.5	7.0	8.0	5.6
-17	7CG7322	Betaseed	16.2	3.7	4.0	5.0	5.2	7.0	7.8	8.3	5.9
-18	Eagle	Spreckels	17.3	3.2	4.0	5.3	6.2	7.5	8.5	8.2	6.1
-19	US H11	Standard	17.0	3.2	3.7	5.7	6.3	7.8	9.0	8.7	6.3
-20	8CG7172	Betaseed	18.0	4.2	4.8	5.7	5.7	8.0	8.7	8.8	6.5
-21	Phoenix	Spreckels	16.5	2.8	3.2	5.5	5.5	7.3	8.5	7.8	5.8
-22	US H11	Standard	16.3	1.8	2.7	5.2	4.8	7.0	8.2	8.3	5.4
-23	Beta 4035R	Betaseed	17.5	3.5	4.2	5.2	5.3	6.8	7.7	8.2	5.8
-24	US H11	Standard	17.8	2.2	3.7	4.3	5.3	6.3	8.3	8.2	5.5
-25	HH 144	Spreckels	16.2	2.5	3.5	4.8	5.0	6.0	7.8	7.7	5.3
-26	Crystal 0024	Crystal	16.5	4.0	4.5	5.7	5.5	7.2	8.2	8.0	6.1
-27	Rodeo	Spreckels	16.8	4.5	5.0	6.0	7.2	8.2	9.0	8.8	7.0
-28	Beta 4864R	Betaseed	17.3	4.3	5.2	6.0	5.7	7.0	8.2	8.5	6.4
-29	Pinnacle	Spreckels	17.8	4.7	5.0	5.8	5.8	7.3	7.5	8.0	6.3
-30	Crystal 9921	Crystal	18.2	1.8	2.7	4.0	4.0	5.7	6.8	7.2	4.6
-31	99HX979	Spreckels	16.8	4.2	5.0	5.5	6.3	7.3	9.0	9.0	6.6
-32	US H11	Standard	17.5	2.3	3.2	4.5	5.2	6.7	7.0	7.8	5.2
-33	Beta 4776R	Betaseed	17.8	2.2	2.5	4.7	5.3	6.7	7.2	8.2	5.2
-34	99HX981	Spreckels	15.0	4.5	4.3	5.3	6.3	7.2	7.5	7.5	6.1
-35	7KJ0191	Betaseed	17.5	5.3	5.8	6.3	7.3	8.2	9.0	9.0	7.3
-36	Rifle	Spreckels	17.7	2.7	4.0	5.3	6.2	6.7	8.5	8.2	5.9

TEST 4201-1. CODED POWDERY MILDEW TEST, SALINAS, CA, 2001

(cont.)

Code No.	Variety	Company	Stand Count No.	Powdery Mildew Score 8/24	8/28	9/06	9/13	9/19	9/25	10/2	Mean
CBGA entries (cont.)											
PM-37	8CG7165	Betaseed	17.0	4.8	5.2	6.0	6.2	7.0	7.8	8.3	6.5
-38	Alpine	Spreckels	17.5	3.2	3.5	5.0	5.3	6.8	7.8	8.0	5.7
-39	Beta 4210R	Betaseed	17.2	2.0	3.5	5.2	5.2	7.2	8.3	8.5	5.7
-40	00HX010	Spreckels	17.2	0.3	0.3	2.0	2.8	3.8	4.8	4.7	2.7
-41	8CG7164	Betaseed	17.5	0.2	0.2	0.8	2.0	3.3	5.0	5.5	2.4
-42	HH 143	Spreckels	17.0	2.0	3.2	4.3	4.2	5.0	6.5	6.7	4.5
-43	Beta 4300R	Betaseed	17.5	4.2	4.8	6.0	6.2	8.0	8.8	9.0	6.7

Variety	Description	Stand Count No.	Powdery Mildew Score 8/24	8/28	9/06	9/13	9/19	9/25	10/2	Mean
USDA checks										
US H11	11-3-99	17.7	3.3	4.3	4.7	5.5	6.7	8.0	8.0	5.8
R039	Inc. R539(C39R)	17.3	0.2	0.8	2.2	1.8	3.5	6.0	5.2	2.8
8918-12	RZM-ER-% 6918-12	17.2	0.0	0.0	0.0	0.3	0.2	1.8	0.7	0.4
00-C37	Inc. U86-37	16.3	3.7	4.8	5.7	6.0	8.3	8.8	9.0	6.6
P007/8	PMR-RZM P807-2;8;P808-7;B	16.2	0.0	0.0	0.2	1.0	1.5	2.2	1.3	0.9
P012	PMR-RZMP912	17.3	0.0	0.0	0.0	0.2	0.3	1.3	0.5	0.3
P017	PMR-RZM P917-#(C)	17.0	0.5	1.2	3.7	3.0	4.8	6.0	7.5	3.8
P018	PMR-RZM P918-#(C)	16.5	0.3	1.0	3.2	3.0	4.7	6.0	6.2	3.5
US H11	11-3-99	16.3	1.2	1.7	3.8	3.8	6.0	7.2	8.7	4.6
Mean		16.9	3.0	3.5	4.7	4.9	6.3	7.3	7.6	5.3
LSD (.05)		1.7	1.5	1.4	1.1	1.1	1.1	1.0	1.1	0.9
C.V. (%)		8.8	44.1	35.7	20.5	20.7	15.0	12.5	12.5	14.6
F value		2.0**	9.3**	10.9**	15.0**	14.4**	19.5**	18.1**	20.8**	23.9**

NOTES: Scored weekly by J.Orozco except 9/13/01 by R.Lewellen on a scale of 0 to 9 where 9 = highly susceptible (90-100% of visible leaf area covered with mildew).

Powdery mildew was slow to develop in 2001. However, late development became moderately severe. Disease development was also more variable than usual. This may have been due to the effects of rhizomania. US H11 susceptible check (USDA entries) was pale yellow from being infected with rhizomania. This appeared to slow the development of mildew on US H11 and to cause some plot to plot variability in powdery mildew development and severity. Late development on US H11, however, was ultimately severe. The rhizomania Resistant commercial varieties did not show the effects of rhizomania infection.

USDA entries: US H11 = powdery mildew susceptible check. 00-C37 = C37 = susceptible line used in breeding program and similar to pollinator of US H11. R039 = C39R = moderately resistant breeding line. 8918-12 = increase of S_1 line with high quantitative (additive) resistance to powdery mildew. P007/8 = line with *Pm* gene from wild beet and selected for resistance. P012 = line with *Pm* gene from wild beet and selected for resistance. P017 & P018 = lines segregating for *Pm* gene from wild beet with C37 background.

TEST 4701. PERFORMANCE OF SMOOTH ROOT AND SALINAS LINES AND HYBRIDS UNDER RHIZOMANIA AND CERCOSPORA, SALINAS, CA, 2001

24 entries x 5 reps, RCB
1-row plots, 17.5 ft. long

Planted: April 11, 2001
Harvested: November 8, 2001

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	No.	No.	%
Checks								
97-SP22-O	Inc. SP 7622-0	3936	14.89	13.15	29	27	165	85.0
Y090	Inc. FS progeny sel.	14656	41.23	17.76	29	29	166	86.6
Smooth Root Lines								
SR96 (95HSL)	EL SR, 3-14-01	6345	19.70	16.02	28	26	162	86.7
SR95	EL SR, 3-14-01	5409	18.38	14.83	29	24	168	88.7
SR94	EL SR, 3-14-01	4357	15.59	14.24	29	25	163	85.9
SR93	EL SR, 3-14-01	3624	14.63	11.18	25	19	144	84.4
SR80	EL SR, 3-14-01	4090	15.56	13.24	27	23	153	85.7
SR87	EL SR, 3-14-01	4200	17.49	12.09	26	25	151	84.9
94HS25	EL SR, 3-14-01	3946	14.05	14.54	30	26	170	84.5
OO-EL0204	RZM 99-EL0204	12514	38.60	16.19	26	25	149	87.0
Experimental & Check Hybrids								
R076-89H50	C790-15CMS x RZM R876-89R	12082	36.22	16.72	28	27	158	88.6
Beta 4430R	010269FH2, 9-8-00	14652	41.71	17.59	29	30	168	89.2
EL17	Michigan variety, 3-27-01	5836	18.99	15.42	27	26	154	88.9
Dorotea	CLSR variety, Italy 3-25-99	12255	34.24	17.91	27	25	153	89.9
CR011H5	C933-5CMS x CR910-912	13173	37.76	17.40	29	28	163	86.9
CR009-1H5	C933-5CMS x CR909-1	13262	36.32	18.26	26	26	147	85.5
Lines and other checks								
CR009-1	RZM CR909-1aa x A, (CR09-1)	9240	25.34	18.29	27	26	152	85.0
CR011	RZM CR910-912aa x A	12492	37.37	16.64	27	28	157	85.7
E740	Inc. E840 (ERR susc. ck.)	4869	17.39	13.99	28	22	160	89.5
R039	Inc. R539 (C39R)	13027	38.30	17.05	26	26	150	87.4
R021	RZM R926,R927 (C26,C27)	11732	34.66	16.99	28	28	160	87.8
R076-89	RZM R976-89R	12582	37.05	16.93	25	24	144	86.8
0931	RZM 9931aa x A	12649	37.82	16.64	26	26	151	86.4
0941	RZM 9941aa x A	13569	39.15	17.29	26	26	146	87.7

TEST 4701. PERFORMANCE OF SMOOTH ROOT AND SALINAS LINES AND HYBRIDS UNDER RHIZOMANIA AND CERCOSPORA, SALINAS, CA, 2001

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Stand Count	Harv. Count	Beets/ 100′	RJAP
		Lbs	Tons	%	No.	No.	No.	%
Mean		9354.1	28.44	15.85	27.4	25.7	156.4	86.9
LSD (.05)		2213.4	6.62	1.22	3.2	4.2	18.1	3.6
C.V. (%)		18.8	18.54	6.13	9.2	13.2	9.2	3.3
F value		28.6**	20.41**	21.25**	1.5NS	2.2**	1.5NS	1.6NS

NOTES: Test 4701 was originally designed and planted to evaluate entries for reaction to *Erwinia* and *Cercospora*. When it was observed that this test was uniformly infected with BNYVV, it was changed to a rhizomania and *Cercospora* evaluation test. The incidence of BNYVV was nearly ideal to make varietal evaluations. The *Rz* allele clearly produced resistant plants where as *rzrz* were fully susceptible except for R039. In addition, this test is known (Dr. H.-Y. Liu) to be uniformly infected with Spinach Spot Virus. At harvest, plots were lifted, plants were hand shaken to remove soil and laid out for individual scoring. Roots were scored for rhizomania on a scale of 0 to 9 where 0 = no evidence of disease and where classes 0 to 4 were considered resistant and 5 to 9 susceptible.

Trial was inoculated with *Cercospora beticola* on 8/21/01 and 8/28/01. CLS was rated on 10/28/01 (by RTL), 11/3/01 (by RTL), and 11/7/01 (by JAOM). The level of disease was moderate but probably did not greatly affect yield because of the late date of inoculation. CLS was rated on a scale of 0 to 9 based upon the approximate per cent defoliation where 9 = 100% defoliated. Corn wind breaks were used to surround this trial and frequent, light sprinkler irrigations were applied to increase dew periods. Powdery mildew was controlled but light infection occurred and the test was scored once on a scale of 0 to 9 where 9 = 90-100% of leaf area covered with visible mildew. Being adjacent to the *Erwinia* inoculated trials, a few beets in line C40 (C740) rotted out.

TEST 4701. PERFORMANCE OF SMOOTH ROOT AND SALINAS LINES AND HYBRIDS UNDER RHIZOMANIA AND CERCOSPORA, SALINAS, CA, 2001

(cont.)

Variety	Description	Powdery Mildew	Cercospora Leaf Spot				Rhizomania Resistance	
		Score	10/28	11/02	11/08	Mean	DI	%R
Checks								
97-SP22-O	Inc. SP 7622-0	1.8	4.0	4.2	2.6	3.6	5.3	6.3
Y090	Inc. FS progeny sel.	0.6	3.4	3.2	1.8	2.8	2.9	92.1
Smooth Root Lines								
SR96 (95HSL)	EL SR, 3-14-01	2.2	5.6	4.6	3.2	4.5	5.2	11.0
SR95	EL SR, 3-14-01	0.8	4.8	4.8	3.8	4.5	4.9	14.7
SR94	EL SR, 3-14-01	1.2	5.0	5.0	3.6	4.5	5.3	7.9
SR93	EL SR, 3-14-01	1.8	5.0	4.6	2.8	4.1	5.1	14.2
SR80	EL SR, 3-14-01	0.0	4.2	3.8	2.2	3.4	5.0	18.3
SR87	EL SR, 3-14-01	1.0	3.8	3.8	1.6	3.1	4.7	22.6
94HS25	EL SR, 3-14-01	3.0	6.2	5.6	4.6	5.5	5.2	11.9
OO-EL0204	RZM 99-EL0204	0.4	4.0	3.8	2.6	3.5	2.9	85.8
Experimental & Check Hybrids								
R076-89H50	C790-15CMS x RZM R876-89R	0.0	3.6	4.0	2.4	3.3	3.6	68.6
Beta 4430R	010269FH2, 9-8-00	0.0	5.4	5.4	6.0	5.6	2.6	92.7
EL17	Michigan variety, 3-27-01	2.0	4.8	5.0	3.0	4.3	5.4	5.9
Dorotea	CLSR variety, Italy 3-25-99	0.2	2.8	2.4	2.2	2.5	3.3	80.1
CR011H5	C933-5CMS x CR910-912	0.6	2.8	3.0	2.2	2.7	3.0	88.7
CR009-1H5	C933-5CMS x CR909-1	0.0	2.6	3.0	2.4	2.7	2.8	100.0
Lines and other checks								
CR009-1	RZM CR909-1aa x A, (CR09-1)	0.6	3.0	3.4	2.2	2.9	2.9	96.4
CR011	RZM CR910-912aa x A	1.8	3.4	3.2	2.4	3.0	3.2	83.4
E740	Inc. E840 (ERR susc. ck.)	3.6	6.4	6.2	4.6	5.7	5.4	4.4
R039	Inc. R539 (C39R)	0.0	3.2	3.4	2.6	3.1	3.0	89.8
R021	RZM R926,R927 (C26,C27)	1.0	4.2	3.8	2.6	3.5	3.0	93.3
R076-89	RZM R976-89R	0.0	3.4	4.0	2.0	3.1	3.3	74.5
0931	RZM 9931aa x A	0.6	3.0	3.6	2.6	3.1	3.1	84.5
0941	RZM 9941aa x A	0.0	3.4	3.6	2.4	3.1	3.1	84.3

TEST 4701. PERFORMANCE OF SMOOTH ROOT AND SALINAS LINES AND HYBRIDS UNDER RHIZOMANIA AND CERCOSPORA, SALINAS, CA, 2001

(cont.)

Variety	Description	Powdery Mildew	Cercospora Leaf Spot				Rhizomania Resistance	
		Score	10/28	11/02	11/08	Mean	DI	%R
Mean		1.0	4.1	4.1	2.9	3.6	3.9	55.5
LSD (.05)		1.5	1.2	1.0	1.0	0.9	0.5	15.6
C.V. (%)		124.2	22.9	19.7	29.0	18.5	9.7	22.3
F value		3.6**	6.8**	6.7**	7.6**	1.0**	40.1**	48.2**

Varieties - 97-SP22-O = increase of pollinator of US H20. Y090 = synthetic (C1) of full-sib families selected and recombined for combined disease resistance. SR#'s = smooth root lines obtained from Dr. Mitch McGrath for national evaluation. 00-EL0204 = line selected for resistance to rhizomania from crosses made at Michigan (Dr. C. Theurer) between SR germplasm and C80*Rz* germplasm. CR011 and CR011H5 = population from Salinas that combines *Rz* with resistance to CLS and its hybrid with monogerm, *RzRz* line C833-5. CR009-1 and CR009-1H5 = progeny line with *RzRz* and CR selected from population CR011 type and its hybrid with monogerm, *RzRz* line C833-5. E740 = C40 = rhizomania susceptible line entered as an *Erwinia* susceptible check and similar to the pollinator of US H9. R039 = C39R = line selected for quantitative resistance to rhizomania and other diseases. R021 = recombined C26 & C27 that are ½ sugarbeet and ½ *B.v.maritima* and selected for resistance to rhizomania and away from easy bolting. R076-89,0931, and 0941 = Salinas populations under selection for multiple disease resistance.

REACTION TO CERCOSPORA LEAF SPOT OF SALINAS LINES
IN FORT COLLINS, CO and SHAKOPEE, MN, 2001

		CR Rating					
Variety	Description	Ft. Collins			Shakopee		
		9/03	9/10	9/17	8/07	8/14	Mean
Checks							
Beta 4430R	Commercial	4.2	6.0	6.3	5.0	7.8	4.8
Phoenix	Commercial				5.0	7.7	4.7
HH141	Commercial				4.1	7.0	4.1
Monohikari	Commercial				4.0	6.7	4.0
Salinas entries							
97-SP22-0	SP7622-0	3.2	4.3	5.3	3.0	5.4	3.2
R021	C26,C27				4.4	6.9	4.1
R039	C39R				4.1	6.0	3.8
Y090	FS (C1,Syn 1)				3.9	6.3	3.9
0931	popn-931	3.3	4.7	5.2	3.7	6.3	3.8
0933	popn-933				3.4	6.4	3.7
CR011	popn CZ11	2.8	3.7	4.5	2.6	6.0	3.6
CR009-1	CR09-1	2.2	4.0	4.8	3.3	5.1	3.1
00-FC1014	RZM FC951014M	2.2	2.8	4.2	4.0	6.6	3.8
00-FC123	RZM-99-FC123	3.5	5.3	6.3	3.6	5.4	3.4
00-EL0204	RZM-99-EL0204	3.3	4.0	4.7	3.7	6.1	3.6
CR 910-2	HS family	2.7	3.7	3.7			
CR911-1	HS family				3.9	5.6	3.6
CR911-3	HS family	2.3	3.8	4.8			
CR911-5	HS				3.3	4.9	3.2
CR911-7	HS	2.5	3.3	4.3	2.9	4.5	2.9
CR911-18	HS	3.0	3.7	4.7			
CR911-21	HS	2.7	3.7	4.0			
CR912-3	HS				3.3	5.7	3.2
CR912-11	HS	2.5	3.3	4.2			
CR912-6	HS	3.1	3.7	4.3	3.7	6.3	3.8
CR911-13	HS	2.3	2.5	4.2			
FC checks							
LSS	931002	4.0	5.7	6.5			
LSR	821051H2	3.0	4.0	5.3			
Betaseed checks							
Check 1					5.0	8.0	4.7
Check 2					3.7	5.4	3.4
Check 3					3.5	5.0	3.0
Check 4					2.0	3.1	2.0
LSD (.05)		0.70	1.26	1.03	0.62	0.90	0.44
Grand mean		3.00	4.00	4.90	3.93	6.39	3.84

LSS = SP351069-0. LRR = (FC504 x 502/2) x SP6322-0.
Shakopee test planted 5/8/01 at U.M.,Rosemount. 3 reps. Inoc. 7/12.
Rated on a scale of 0 to9.
Acknowledgements: Lee Panella and Linda Hanson at Fort Collins, CO, and Margaret Rekoske and Jay Miller at Betaseed, Shakopee, MN.

TEST 101. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA, 2000-2001

100 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 10, 2000
Not harvested for yield

Variety	Description	Stand Count	% Bolting			Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	Mean	Score	Mean	%
Checks									
Beta 4776R	Betaseed, 010228FH2, 9-8-00	28.0	2.4	16.3	27.0	4.3	1.0	1.5	0.0
Beta 4430R	Betaseed, 010269FH2, 9-8-00	29.3	3.2	17.9	27.0	5.0	1.0	2.2	0.0
HH142	Spreckels, 9-7-00	26.0	18.0	35.8	43.8	5.5	1.7	0.5	0.0
Beta 6600	Betaseed, L9N490018AA, 7-11-00	28.7	0.0	3.7	7.0	6.0	1.3	0.7	0.0
Monohikari	Seedex, L7383, 3-1-00	28.3	80.1	89.5	95.3	5.3	1.7	1.7	0.0
Crystal 205	L0205C8602, 3-1-00	29.0	39.2	64.8	67.1	5.3	1.0	3.2	0.0
Phoenix	Spreckels, 3-2-00	26.0	0.0	10.6	17.2	4.8	1.7	1.8	0.0
Alpine	Spreckels, 3-2-00	27.0	13.4	19.8	26.4	4.8	1.3	1.8	0.0
SS-NB3	Spreckels, 4-96	29.3	0.0	9.2	11.2	6.5	1.3	0.5	0.0
US H11	new, 11-3-99	29.7	2.3	5.7	6.9	6.8	1.0	0.7	0.0
US H11	11-3-99	27.7	0.0	3.5	3.5	7.2	1.3	1.0	2.5
00-US75	Inc. 97-US75	28.7	0.0	4.6	8.1	6.2	1.7	1.2	1.1
Hybrids with C833-5									
R078H5	9833-5(T-O)HO x R978	25.0	7.6	16.0	18.6	5.3	2.7	2.7	1.4
R078H7	9833-5aa x R978	25.3	5.3	13.2	18.6	6.0	2.3	1.7	0.0
0941H5	9833-5(T-O)HO x RZM 9941	28.0	2.5	9.6	14.5	5.8	1.7	0.7	0.0
0931H5	9833-5(T-O)HO x RZM 9931	25.7	2.6	3.9	6.5	5.2	2.0	1.8	0.0
Z025H5	9833-5(T-O)HO x RZM Z925	24.3	2.8	12.4	17.9	5.5	2.3	0.8	1.4
CR011H5	9833-5(T-O)HO x RZM CR910,11,12	27.0	14.8	28.4	35.8	5.5	2.3	0.7	2.5
0927-29H5	9833-5(T-O) x 8927-29	26.7	1.1	11.1	16.0	5.0	2.0	1.0	0.0
0929-112H5	9833-5HO x 8929-112	26.3	9.2	14.5	15.8	4.8	1.7	1.5	2.6
0929-114H5	9833-5HO x 8929-114	26.0	3.8	9.0	12.8	5.8	1.7	1.8	1.3
0930-9H5	9833-5HO x 8930-19	26.3	0.0	2.5	3.7	5.5	1.3	1.2	0.0
Z025-9H5	9833-5HO x Z825-9	27.3	4.9	8.6	13.4	4.5	1.7	0.8	0.0
CR009-1H5	9833-5HO x CR909-1	25.3	2.8	12.1	21.2	6.3	2.0	1.7	0.0

TEST 101. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting			Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	Mean	Score	Mean	%
Hybrids with C833-5 (cont.)									
0911-4-10H5	9833-5HO x 9911-4-10	27.7	0.0	1.3	1.3	5.7	1.7	0.0	0.0
R021H5	9833-5(T-O)HO x R926,7	28.0	8.4	14.3	23.8	6.3	1.3	2.8	1.2
N065H5	9833-5(T-O)HO x RZM N965(g)	25.7	0.0	0.0	1.3	4.8	2.3	2.2	0.0
R076-89-18H5	9833-5(T-O)HO x RZM R976-89-18	24.3	5.6	6.9	8.3	3.5	1.7	2.0	4.5
Experimental hybrids with C78 pollinator									
R078H50	F92-790-15CMS x R978	27.3	0.0	6.3	7.4	5.0	1.7	1.5	0.0
R078H50(99)	99-790-15CMS x R978	29.0	11.5	17.0	27.3	5.3	1.0	1.7	3.6
R078H5	9833-5(T-O)HO x R978	23.3	7.2	10.4	14.5	5.8	2.3	1.8	0.0
R078H3	97-562HO x R978	25.0	6.8	13.4	18.8	5.8	2.7	2.2	0.0
R078H37	4807HO (C306/2HO) x R978	28.3	15.0	16.3	16.3	4.7	2.3	2.2	0.0
R078H2	9831-3HO x R978	23.7	6.0	11.6	14.2	5.5	2.7	3.5	0.0
R078H27	9831-4HO x R978	28.0	14.1	17.7	18.9	5.3	2.0	1.2	1.1
R078H46	9869-5HO x R978	26.0	10.1	16.2	23.6	5.7	2.3	2.0	0.0
R078H45	9867-1HO x R978	26.0	25.4	27.9	33.1	5.2	2.7	1.3	2.6
R078H30	9829-3HO x R978	27.3	9.4	15.5	20.2	5.5	2.3	1.7	1.3
R078H13	9833-12HO x R978	28.3	7.3	19.9	24.4	5.5	2.3	2.2	0.0
R078H70	RZM 9869HO x R978	28.7	8.2	12.8	12.8	6.0	2.0	3.0	0.0
R078H55	9833(T-O)HO x R978	27.7	6.0	19.4	30.2	5.7	1.7	1.7	1.2
R078H35	9835(T-O)aa x R978	29.0	9.2	15.0	19.6	5.7	1.0	2.7	0.0
R078H33	9833aa x R978	27.7	13.3	15.6	21.7	6.8	1.3	3.2	6.0
R078H7(MR)	RZM 9833-5aa x R978	21.0	6.2	9.4	15.8	5.8	3.0	2.8	0.0
R078H69	9869aa x R978	28.7	5.8	12.9	16.3	6.0	1.3	1.3	1.1
R078H19	RZM 9818maa x R978	27.0	1.3	10.1	11.3	5.3	2.0	1.2	0.0

TEST 101. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count No.	% Bolting 6/19	% Bolting 7/26	% Bolting 8/29	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Experimental hybrids with popn-941 pollinator									
0941H50	F92-790-15CMS x RZM 9941	27.0	2.3	4.7	7.3	5.2	1.3	1.0	1.3
0941H5	9833-5(T-O)HO x RZM 9941	27.0	8.5	13.5	14.7	5.0	1.7	1.3	0.0
0941H2	9831-3HO x RZM 9941	29.3	1.2	6.9	6.9	4.3	1.3	2.0	0.0
0941H27	9831-4HO x RZM 9941	26.7	0.0	1.3	2.5	5.3	1.3	2.8	0.0
0941H45	9867-1HO x RZM 9941	27.0	18.7	33.6	42.0	5.2	1.7	1.0	1.1
0941H46	9869-6HO x RZM 9941	25.7	0.0	4.0	6.7	5.7	1.7	1.2	0.0
0941H37	4807(C306/2CMS) x RZM 9941	28.0	1.2	4.8	8.3	4.5	1.3	0.8	0.0
0941H55	9835(T-O)HO x RZM 9941	26.0	1.3	12.8	20.6	5.3	1.3	1.0	0.0
0941H56	9836HO x RZM 9941	27.3	1.2	2.5	7.4	6.3	1.7	0.2	0.0
0941H70	9869HO x RZM 9941	27.7	2.6	7.3	12.1	5.5	1.3	0.3	1.1
Hybrids with C790-15CMS									
R078H50	F92-790-15CMS x R978	26.7	9.9	17.5	20.0	5.2	1.7	0.5	0.0
0941H50	F92-790-15CMS x RZM 9941	27.7	3.4	8.4	12.0	4.7	1.3	0.7	1.2
0931H50	F92-790-15CMS x RZM 9931	27.0	6.2	7.4	9.8	5.2	2.0	0.8	1.3
Z025H50	F92-790-15CMS x RZM Z925	28.3	3.6	8.3	13.0	5.7	1.7	1.2	0.0
CR011H50	F92-790-15CMS x RZM CR910,11,12	25.3	8.0	23.7	27.6	5.7	1.3	0.7	0.0
0927-29H50	99-790-15CMS x 8927-29	28.0	0.0	10.6	13.0	5.2	1.3	0.3	0.0
0929-112H50	99-790-15CMS x 8929-112	27.3	6.1	10.5	15.4	5.5	1.3	0.2	0.0
0929-114H50	99-790-15CMS x 8929-114	27.0	3.5	9.4	11.7	5.7	1.3	0.0	3.8
0930-19H50	99-790-15CMS x 8930-19	27.7	0.0	1.2	2.6	5.0	1.7	0.3	2.2
Z025-9H50	99-790-15CMS x Z825-9	28.3	4.7	15.1	20.1	4.3	1.3	0.2	0.0
CR009-1H50	99-790-15CMS x CR909-1	25.0	10.6	19.9	29.2	6.0	1.7	0.8	4.0
0911-4-10H50	99-790-15CMS x 9911-4-10m	27.0	8.5	8.6	9.8	4.8	1.7	0.2	0.0

TEST 101. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count No.	% Bolting 6/19	7/26	8/29	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Hybrids with C790-15CMS (cont.)									
R021H50	99-790-15CMS x RZM R926,7	28.0	13.0	28.2	30.6	6.5	1.3	1.5	1.2
Y075H50	C790-15CMS x RZM-%S Y875	29.0	3.3	6.6	7.6	4.8	1.0	3.0	1.3
0926H50	C790-15CMS x RZM-%S 8926	28.3	2.3	4.7	9.5	4.5	1.3	2.2	0.0
0942H50	C790-15CMS x RZM-% R576-89-18H18,19	29.0	0.0	2.4	2.4	4.2	1.3	0.8	0.0
Y072-4H50	C790-15CMS x Y872	28.0	0.0	0.0	1.1	5.0	1.0	0.7	0.0
P007/8H50	C790-15CMS x PMR-RZM P807,8	26.7	1.2	3.8	7.4	4.2	1.3	1.8	1.2
Y068-1H50	C790-15CMS x Y868-1	28.7	0.0	1.2	2.3	5.3	1.3	2.5	0.0
R078-9H50	C790-15CMS x R878-9	27.0	0.0	2.5	3.8	5.0	1.0	2.2	0.0
R076-89H50	C790-15CMS x RZM R976-89R	29.3	1.1	3.4	6.8	4.5	1.3	1.7	1.1
0936H50	C790-15CMS x 8936	28.0	0.0	2.4	4.9	4.2	1.3	1.3	0.0
Y067H50	C790-15CMS x RZM Y967	27.3	0.0	6.0	6.0	4.8	1.0	1.8	0.0
R036H50	C790-15CMS x RZM R936	29.0	3.4	11.5	15.0	6.0	1.0	0.8	1.1
0747H50	C790-15CMS x 7747	25.7	0.0	6.6	7.8	6.0	1.7	0.5	1.3
P019H50	C790-15CMS x PMR-RZM P919-#(C)	28.3	3.6	9.5	11.9	4.0	1.0	2.3	0.0
P020H50	C790-15CMS x PMR-RZM P920-#(C)	29.3	12.5	19.2	35.5	5.7	1.0	2.7	1.1
P007H50	C790-15CMS x PMR-RZM P907	28.7	7.1	16.4	21.0	4.8	1.3	3.0	0.0
P012H50	C790-15CMS x PMR-RZM P912	28.7	20.9	26.7	31.4	4.7	1.3	2.2	0.0
0934H50	C790-15CMS x RZM 9934	29.0	2.3	4.6	6.9	5.5	1.0	2.3	0.0
Y071H50	C790-15CMS x RZM Y971	26.3	0.0	1.2	2.5	5.3	1.7	2.0	0.0
R078-3H50	C790-15CMS x R878-3	28.0	0.0	3.6	6.0	5.3	1.0	1.3	0.0
R078-4-H50	C790-15CMS x R878-4	28.3	0.0	0.0	1.1	5.2	1.0	2.2	0.0
R080-5H50	C790-15CMS x R880-5	28.7	1.1	3.5	6.9	5.7	1.0	1.0	0.0
R080-9H50	C790-15CMS x R880-9	27.7	0.0	0.0	0.0	5.2	1.3	0.8	0.0
R080/2-11H50	C790-15CMS x R880/2-11	28.0	0.0	1.3	1.3	4.7	1.3	1.5	1.2

TEST 101. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting			Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	Mean	Score	Mean	%
Hybrids with C790-15CMS (cont.)									
0931-5H50	C790-15CMS x 8931-5	27.0	0.0	0.0	0.0	5.2	1.7	0.2	0.0
9031-7H50	C790-15CMS x 8931-7	28.7	7.0	7.0	9.4	3.7	1.0	0.7	0.0
0936-11H50	C790-15CMS x 8936-11	28.0	0.0	2.3	4.8	4.2	1.7	1.5	0.0
0936-10H50	C790-15CMS x 8936-10(DMS)	29.3	2.3	7.9	10.2	5.2	1.0	2.2	0.0
0936-16H50	C790-15CMS x 8936-16(DMR)	28.7	0.0	3.7	5.9	4.5	1.7	0.7	0.0
9929-62H50	C790-15CMS x 7929-62VY	27.3	0.0	1.2	1.2	4.5	1.7	1.5	0.0
9930-35H50	C790-15CMS x 7930-35	26.3	0.0	1.3	2.7	5.8	2.7	0.7	0.0
9924-78H50	C790-15CMS x 7924-78	27.3	0.0	1.2	2.5	5.5	2.0	0.3	0.0
Mean		27.3	5.8	11.4	15.0	5.3	1.6	1.4	0.6
LSD (.05)		2.8	7.3	9.7	11.3	1.0	0.9	2.6	2.6
C.V. (%)		6.4	78.4	52.9	46.9	12.0	35.6	111.0	259.9
F value		2.2**	14.3**	12.7**	11.6**	3.4**	2.2**	0.8NS	1.5**

TEST 401. EVALUATION OF HYBRIDS WITH SELECTED PROGENY LINES FOR NONBOLTING, SALINAS, CA, 2000-2001

40 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 10, 2000
Not harvested for yield

Variety	Description	Stand Count No.	% Bolting 6/19	7/26	8/29	9/25	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Checks										
R078H50	C790-15CMS x R978	26.0	9.2	19.0	22.9	26.7	6.0	2.0	1.3	2.5
US H11	new, 9-14-99	28.3	0.0	4.8	9.5	9.5	6.2	1.3	1.5	0.0
Hybrids with FS progeny lines										
R078-3H50	C790-15CMS x R878-3	28.7	0.0	2.3	5.8	5.8	5.6	1.7	1.8	0.0
R078-4H50	C790-15CMS x R878-4	28.0	0.0	0.0	0.0	0.0	4.8	1.0	1.7	0.0
R078-8H50	C790-15CMS x R878-8	27.7	0.0	1.2	1.2	3.7	4.7	1.7	1.3	0.0
R078-9H50	C790-15CMS x R878-9	29.0	1.2	3.4	4.6	4.6	5.6	1.0	2.0	0.0
R076-89H50	C790-15CMS x RZM R876-89R	29.3	4.6	14.9	14.9	16.0	4.2	1.0	1.5	0.0
R076-89-5H50	C790-15CMS x R876-89-5,NB	29.3	2.3	9.2	10.3	11.5	4.2	1.3	1.8	0.0
R076-89-5-9H50	C790-15CMS x R876-89-5NB-9	29.0	0.0	0.0	1.1	2.3	3.8	1.3	0.8	0.0
R076-89-18H5	9833-5(T-O)HO x RZM R876-89-18	28.0	5.9	11.7	12.9	12.9	4.1	1.0	1.5	0.0
Y068-1H50	C790-15CMS x Y868-1	29.0	0.0	1.1	2.3	2.3	6.6	1.7	1.3	0.0
Y068-2H50	C790-15CMS x Y868-2	30.0	0.0	0.0	3.4	3.4	5.1	1.0	1.5	0.0
Y068-4H50	C790-15CMS x Y868-4	28.0	2.5	5.0	9.5	9.5	5.4	1.3	1.7	1.3
Y068-6H50	C790-15CMS x Y868-6	29.0	4.7	8.1	17.4	18.6	4.3	1.3	1.0	0.0
Y069-13H50	C790-15CMS x Y868-13	29.0	0.0	2.3	5.8	9.2	4.4	1.0	2.5	0.0
Y069-18H50	C790-15CMS x Y869-18	29.0	1.1	7.9	10.1	10.1	4.7	1.0	3.8	0.0
Y069-26H50	C790-15CMS x Y869-26	29.0	0.0	5.9	8.1	8.1	5.6	1.0	2.2	0.0
R070-9H50	C790-15CMS x R870-9	27.7	7.1	13.1	17.7	18.9	5.0	1.3	2.2	0.0
R080-5H50	C790-15CMS x R880-5	29.3	1.1	4.6	6.9	6.9	6.2	1.3	1.8	0.0
R080-9H50	C790-15CMS x R880-9	29.7	0.0	0.0	0.0	0.0	5.1	1.0	3.3	0.0

TEST 401. EVALUATION OF HYBRIDS WITH SELECTED PROGENY LINES FOR NONBOLTING, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting				Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	9/25	Mean	Score	Mean	%
Hybrids with FS progeny lines (cont.)										
R080-13H50	C790-15CMS x R880-13	28.0	0.0	0.0	0.0	0.0	5.7	1.3	3.3	0.0
R080/2-9H50	C790-15CMS x R880/2-9	28.7	0.0	1.1	6.8	7.9	5.8	1.0	1.2	0.0
R080/2-11H50	C790-15CMS x R880/2-11	29.7	1.1	4.4	6.6	6.6	5.1	1.0	1.5	0.0
R080-45-10H50	C790-15CMS x R880-45-10	28.7	0.0	0.0	1.1	1.1	4.7	1.0	2.0	1.1
Y067-3H50	C790-15CMS x Y867-3	26.7	11.3	19.9	22.5	22.5	6.2	2.0	2.3	0.0
Y072-4H50	C790-15CMS x Y872-4	27.7	1.2	3.6	7.2	8.4	6.0	1.0	1.2	1.2
Hybrids with S_1 progeny lines										
0931-5H50	C790-15CMS x 8931-5	27.0	0.0	0.0	2.6	2.6	5.6	2.7	1.0	0.0
0931-7H50	C790-15CMS x 8931-7	28.3	2.4	11.9	13.0	15.4	3.7	1.3	1.7	0.0
0935-25H50	C790-15CMS x 8935-25	27.3	1.2	1.2	2.4	2.4	5.8	2.3	0.2	0.0
0936-8H50	C790-15CMS x 8936-8	27.0	0.0	0.0	0.0	1.2	3.9	2.0	0.3	1.2
0936-10H50	C790-15CMS x 8936-10	29.3	1.1	7.8	12.2	13.3	5.2	1.0	1.2	0.0
0936-11H50	C790-15CMS x 8936-11	27.3	0.0	0.0	1.2	1.2	3.6	1.0	1.8	1.2
0936-16H50	C790-15CMS x 8936-16	27.0	0.0	3.5	7.5	8.6	4.6	1.0	0.5	0.0
0934-5H50	C790-15CMS x 8934-5	25.7	3.9	9.2	10.5	13.1	6.7	2.3	0.3	0.0
Z025-9H50	C790-15CMS x Z825-9	28.0	1.2	15.5	26.2	31.0	4.6	1.0	0.2	0.0
0929-112H50	C790-15CMS x 8929-112	28.0	11.0	19.6	23.3	24.4	4.8	1.3	1.7	0.0
0929-114H50	C790-15CMS x 8929-114	29.0	3.4	12.6	23.0	23.0	5.3	1.3	0.3	0.0
0930-19H50	C790-15CMS x 8930-19	28.0	1.1	7.3	8.4	8.4	5.1	1.3	0.3	1.2
0927-29H50	C790-15CMS x 8927-29	29.7	4.6	17.0	26.1	26.1	5.2	1.7	0.5	0.0
CR009-1H50	C790-15CMS x CR909-1	26.3	8.9	21.8	30.6	31.8	6.0	1.7	1.0	3.8
Mean		28.3	2.3	6.8	9.9	10.7	5.1	1.4	1.5	0.3
LSD (.05)		2.6	3.9	9.0	11.1	11.3	1.0	0.7	2.1	1.5
C.V. (%)		5.6	103.6	81.7	69.2	64.8	12.3	32.7	87.6	263.9
F value		1.4NS	5.5**	4.3**	4.6**	5.0**	5.0**	2.9**	1.3NS	2.4**

TEST 201. EVALUATION OF BREEDING LINES AND POPULATIONS, SALINAS, CA, 2000-2001

100 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 10, 2000
Not harvested for yield

Variety	Description	Stand Count No.	% Bolting 6/19	% Bolting 7/26	% Bolting 8/29	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Checks									
US H11	new, 11-3-99	29.0	1.1	4.5	9.1	6.7	1.7	1.2	0.0
SS-NB3	Spreckels, 1996	30.3	1.1	4.4	7.6	6.2	1.7	0.3	0.0
Beta 4776R	Betaseed, 010228FH2, 9-8-00	28.0	0.0	11.8	20.1	4.5	1.0	1.5	0.0
HH142	Spreckels, 9-7-00	29.0	13.2	44.4	53.5	5.7	1.7	2.0	1.3
00-US75	Inc. 97-US75	27.0	0.0	6.5	10.4	6.5	2.0	0.8	1.4
00-C37	Inc. U86-37	28.0	0.0	0.0	1.1	6.7	1.7	1.8	2.8
97-US22/3	Inc. Y009 (US22/3)	28.0	70.3	79.9	81.2	6.2	2.3	1.2	0.0
00-SP22-0	Inc. 97-SP22-0	27.7	80.5	87.9	92.6	5.3	1.0	2.0	0.0
99-C46/2	Inc. U86-46/2	27.7	0.0	2.5	2.5	5.5	1.3	3.2	0.0
R978	RZM-ER-% R778,%	27.0	5.0	14.0	18.8	5.2	1.7	4.2	0.0
R078(Iso)	Inc. R978	26.7	12.8	20.2	21.4	4.3	1.7	2.0	1.2
R078(Sp)	Inc. R978	25.3	13.1	21.1	26.3	4.3	2.0	1.5	0.0
Multigerm, open-pollinatoed lines									
R980	RZM-ER-% R780/2,…	25.7	1.4	6.6	7.8	4.5	1.7	1.8	0.0
Y090	Inc. FS progeny selection	28.7	4.6	10.3	12.6	4.8	1.7	2.7	0.0
R039	Inc. R539, (C39R)	25.7	6.4	24.8	29.9	5.0	2.0	2.0	2.6
99-C31/6	Inc. F86-31/6	28.3	0.0	2.4	4.7	4.3	2.0	3.8	0.0
Y969(Iso)	RZM-ER-% Y769, (C69)	28.0	6.1	23.5	33.2	5.0	1.7	2.7	0.0
Y967	RZM-ER-% Y767	25.7	7.6	24.6	28.7	5.3	1.3	2.0	0.0
Y067	RZM Y967	26.7	18.8	25.0	30.0	4.5	1.7	3.2	0.0
Y971	RZM-ER-% Y771	26.3	5.0	10.0	13.9	5.8	1.3	3.5	0.0
Y975	RZM Y875	25.7	9.7	22.5	28.4	5.2	1.3	4.0	2.4
Y075	RZM-%S Y875 (Sp)	26.3	13.0	22.8	24.1	5.3	1.7	4.0	0.0
R036	RZM R936	26.7	8.9	22.9	26.5	6.5	1.7	1.3	0.0
R021	RZM R926,R927,(C26,C27)	25.3	23.4	34.1	45.4	5.3	2.0	2.3	1.3

TEST 201. EVALUATION OF BREEDING LINES AND POPULATIONS, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting			Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	Mean	Score	Mean	%
Multigerm, open-pollinatoed lines (cont.)									
Y071	RZM Y971	28.0	0.0	1.1	2.2	5.7	1.7	3.7	0.0
P007/8	PMR-RZM P807-2; P808-7	27.3	2.5	4.9	8.5	3.2	1.0	5.8	0.0
P017	PMR-RZM P917-#(C)	27.3	13.5	17.2	19.6	5.3	1.3	3.0	0.0
P018	PMR-RZM P918-#(C)	27.0	23.3	39.3	48.1	4.0	1.7	3.3	0.0
P019	PMR-RZM P919-#(C)	25.7	6.4	16.9	31.0	4.8	1.3	4.0	0.0
P020	PMR-RZM P920-#(C)	28.7	28.7	46.2	54.4	5.3	1.0	3.8	0.0
P007	PMR-RZM P907	28.3	1.1	6.6	9.1	4.5	2.0	4.0	1.2
00-EL0204	RZM 99-EL-02,04	27.3	27.8	35.0	39.9	4.8	2.0	2.7	0.0
Multigerm,S^f,Aa populations & lines									
9931	RZM 8931aa x A	26.7	6.6	16.4	21.3	4.5	1.7	3.8	0.0
0931	RZM 9931aa x A	27.0	11.1	20.8	24.3	4.7	2.0	3.7	0.0
9933	8933aa x A	28.0	8.2	11.9	13.1	4.7	1.0	2.7	1.2
9941	941(C)aa x A	26.3	1.2	5.0	7.6	4.3	1.0	2.5	0.0
0941	RZM 9941aa x A	27.3	0.0	3.8	3.8	4.0	1.7	1.2	0.0
Z025	RZM Z925aa x A	26.7	28.3	44.6	49.7	5.2	1.7	0.7	0.0
9926	RZM 8926aa x A	27.3	7.2	21.8	28.0	4.5	1.7	3.7	0.0
0926	RZM-%S 8926 (A,aa)	27.7	3.6	8.4	16.6	5.2	1.0	5.0	0.0
0921	RZM 9926aa x R926,7	26.3	13.7	30.3	33.8	6.3	2.0	3.7	0.0
CR911(Sp)	CR811(C)aa x A(C)	26.3	21.7	30.3	34.2	5.7	2.0	4.8	2.6
CR011	RZM CR910,11,12(C)aa x A	26.3	41.9	54.5	60.8	5.7	1.7	3.7	0.0
CR009-1	RZM CR909-1aa x A	25.3	14.6	24.4	32.3	5.8	2.3	0.7	12.0
0934	RZM 9934 (A,aa)	27.7	8.2	15.4	21.2	6.2	1.7	2.8	0.0
P012	PMR-RZM P912 (A,aa)	28.0	15.3	25.9	33.1	4.7	1.3	4.8	0.0
0747	Inc. 7747 (A,aa)	29.0	2.3	2.3	3.4	6.2	1.0	4.5	3.5
0936	Inc. 8936 (A,aa)	26.3	7.7	18.2	23.1	4.3	1.0	4.0	0.0

TEST 201. EVALUATION OF BREEDING LINES AND POPULATIONS, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count No.	% Bolting 6/19	% Bolting 7/26	% Bolting 8/29	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Multigerm, S^f, Aa populations & lines (cont.)									
0942	RZM-%S R576-89-18H18,19 (Aa)	27.0	2.6	6.5	6.5	3.2	1.7	4.0	2.5
N024	RZM N925,6; N931,2 (A,aa)	27.3	10.9	23.2	28.1	3.3	1.3	6.3	0.0
N065M	RZM N965m (galls)	28.7	0.0	1.1	3.4	3.5	1.0	4.3	0.0
N065m	RZM N965mm (galls)	27.3	0.0	2.5	2.5	2.8	2.0	4.7	0.0
Monogerm, S^f, Aa populations & lines									
9835	RZM 8835mmaa x A	28.0	0.0	6.8	11.4	5.0	1.3	1.8	2.5
0835(Sp)	RZM 9833,5aa x A	25.3	4.0	11.0	14.5	5.0	1.7	1.3	5.7
0835HO	9835(T-O)HO x " "	28.3	4.8	8.7	8.7	5.2	1.3	1.2	2.4
0835H5	9833-5(T-O)HO x " "	26.3	7.5	16.6	16.6	5.0	1.7	1.8	2.6
0835(Iso)mm	RZM-% 8835(A,aa)mm	29.3	0.0	4.6	5.7	4.7	1.3	1.3	0.0
0838mm	RZM-% 8838(A,aa)mm	28.3	2.3	15.0	26.8	5.5	1.0	1.7	0.0
0848M	RZM-% 8848,8810 (A,aa)	28.0	0.0	2.4	4.9	5.3	1.3	1.0	0.0
0835NBM	NB-%S 8835 (A,aa)	30.7	0.0	2.2	5.4	6.2	1.0	0.7	0.0
0836	RZM 9836mmaa x A	24.0	3.2	5.7	10.0	5.7	2.0	0.2	0.0
0836H5	9833-5(T-O)HO x " "	27.3	0.0	0.0	2.6	6.2	1.0	0.0	0.0
0836H7	8833-5aa x " "	25.3	1.2	5.1	5.1	6.0	2.3	0.3	1.3
0841H5	9833-5(T-O)HO x 841(C)	26.7	2.7	8.8	13.7	5.8	1.3	0.8	1.2
0841H7	9833-5aa x 841(C)	26.7	1.2	6.2	8.8	5.8	1.0	0.3	11.1
0841H35	9835T-Oaa x 841(C)	29.0	9.1	20.2	24.8	5.7	1.0	0.2	4.3
0841H69	RZM 9869aa x 841(C)	29.0	3.3	14.6	21.5	5.8	1.0	0.5	0.0
0562	Inc. 97-562 (C562)	25.7	0.0	2.8	4.2	3.3	1.7	0.2	7.2
0546	Inc. 97-546 (C546)	21.7	0.0	0.0	0.0	4.5	1.7	0.0	6.0
0718	Inc. 97-718 (C718)	25.0	0.0	0.0	0.0	1.8	1.7	0.2	1.3
0762-17	Inc. 6762-17 (C762-17)	26.3	0.0	0.0	0.0	2.2	1.3	0.3	4.0
00-FC1041m	RZM-%S FC951014mm	30.0	16.0	28.1	29.0	5.0	1.0	0.5	0.0

TEST 201. EVALUATION OF BREEDING LINES AND POPULATIONS, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting			Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	Mean	Score	Mean	%
Monogerm, S^f, Aa populations & lines (cont.)									
00-FC123	RZM 99-FC1-2,-2mm	26.3	0.0	2.6	4.0	5.2	2.0	0.3	1.2
0833-5(Iso)	RzRz,T-O,8833-5(C)	27.0	2.5	7.5	10.0	4.8	1.7	3.7	0.0
0833-5(Sp)	RZM 9833-5(T-O)mmaa x A	25.3	1.4	9.5	9.5	4.5	1.7	1.3	5.5
0833-5H0(Sp)	RZM 9833-5(T-O)HO x " "	26.0	2.6	9.0	11.5	4.5	2.0	1.2	0.0
0833-5H50	C790-15CMS x " "	28.3	0.0	2.3	9.4	5.2	1.0	0.5	4.9
0833-5H2	RZM 9831-3HO x " "	26.3	6.3	12.4	17.6	5.0	1.7	0.3	10.3
0833-5H27	RZM 9831-4HO x " "	29.7	1.0	2.3	4.6	4.3	1.0	0.5	0.0
0833-5H45	RZM 9867-1HO x " "	25.7	17.9	29.9	32.4	4.8	1.0	0.7	1.3
0833-5H46	RZM 9869-6HO x " "	25.0	4.0	10.7	12.0	6.3	1.3	0.2	4.0
00-790-15	Inc. F92-790-15, (C790-15)	27.3	0.0	1.2	2.4	3.0	1.0	0.3	4.8
00-790-15CMS	U88-790-68CMS x " "	27.0	0.0	3.7	4.9	4.7	1.3	0.5	2.4
0911-4-10(Iso)	RZM 9911-4-10-#(C)mm	22.3	0.0	0.0	0.0	4.0	3.3	0.2	0.0
0911-4-10H50(Iso)	C790-15CMS x " "	28.3	1.1	4.8	8.4	5.0	1.0	0.5	0.0
0911-4-10(Sp)	Inc. 9911-4-10(C)mm	25.3	0.0	0.0	0.0	4.3	3.0	0.2	0.0
0911-4-10H50	C790-15CMS x " "	29.3	1.1	4.4	6.7	4.8	1.3	0.0	0.0
0911-4-10H5	9833-5HO x " "	27.7	0.0	0.0	0.0	5.0	2.3	0.2	0.0
0911-4-10H7	9833-5aa x 9911-4-10m	27.7	0.0	0.0	0.0	4.3	3.0	0.2	0.0
0833-10	RZM 9833-10(A,aa)mm	28.7	0.0	0.0	0.0	1.5	1.3	0.0	0.0
0831-4-10	Inc. 9831-4-10	28.3	0.0	0.0	0.0	2.8	2.3	0.2	0.0
0831-4-7	Inc. 9831-4-7	28.0	0.0	0.0	0.0	4.2	1.7	0.0	0.0
N030-5NN	RZM-NR N930-5 (galls)	17.3	0.0	0.0	0.0	1.2	4.0	0.2	0.0
N030-5NNH50	C790-15CMS x " "	28.3	0.0	2.3	4.7	3.0	1.7	0.7	0.0
0834-2	Inc. 8834-2(A,aa)mm	29.7	0.0	0.0	1.1	3.0	1.3	0.5	2.3
0836-1M	Inc. 8836-1(A,aa)M	28.0	0.0	0.0	0.0	2.7	1.3	1.3	1.2

TEST 201. EVALUATION OF BREEDING LINES AND POPULATIONS, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting			Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	Mean	Score	Mean	%
Monogerm, S^f, Aa populations & lines (cont.)									
8836-7	Inc. 8836-7(A,aa)mm	28.3	0.0	0.0	0.0	0.7	1.0	0.8	1.2
0837-6M	Inc. 8837-6(A,aa)M	27.0	0.0	0.0	0.0	4.5	1.7	1.0	0.0
0808-9	Inc. 8809-9(A,aa)mm	28.7	0.0	1.1	1.1	2.5	1.0	0.2	2.3
0808-15	Inc. 8808-15(A,aa)mm	27.7	0.0	0.0	0.0	2.5	1.3	0.2	7.2
Mean		27.1	7.0	13.2	16.4	4.7	1.6	1.9	1.3
LSD (.05)		3.3	8.5	10.3	10.7	1.1	0.9	2.3	4.6
C.V. (%)		7.7	75.4	48.2	40.3	15.2	33.3	75.1	210.8
F value		2.3**	17.1**	18.8**	21.2**	8.9**	3.0**	4.0**	2.3**

TEST 301. EVALUATION OF SELECTED PROGENY LINES FOR NONBOLTING, SALINAS, CA, 2000-2001

40 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 10, 2000
Not harvested for yield

Variety	Description	Stand Count No.	% Bolting 6/19	7/26	8/29	9/25	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Checks										
R078(Iso)	Inc. R978	27.7	8.5	14.5	19.4	21.8	5.2	2.0	2.8	0.0
00-C37	Inc. U86-37	24.7	5.8	5.8	5.8	5.8	6.1	2.0	4.8	0.0
Inc. FS progeny from MM,S^sS^s lines										
R078-3	Inc. R878-3	27.7	0.0	0.0	0.0	0.0	5.1	1.7	5.7	0.0
R078-4	Inc. R878-4	28.0	0.0	4.8	7.1	7.1	3.9	1.3	3.2	0.0
R078-8	Inc. R878-8	27.0	0.0	2.4	2.4	3.7	4.4	1.3	3.3	0.0
R078-9	Inc. R878-9	28.0	0.0	0.0	3.6	3.6	4.9	1.3	4.5	0.0
R076-89	RZM R976-89R	28.0	5.9	11.8	15.2	15.2	3.1	1.3	4.3	0.0
R076-89-5	R876-89-5,NB	28.7	5.7	8.1	12.7	16.1	3.8	1.3	2.2	0.0
R076-89-5-9	R876-89-5NB-9	28.0	0.0	2.5	3.7	3.7	2.2	2.0	1.2	0.0
R076-89-18	RZM R976-89-18	12.0	13.6	21.3	23.8	23.8	3.1	5.0	1.5	0.0
Y068-1	Inc. Y868-1	24.3	0.0	0.0	0.0	0.0	4.8	1.0	4.7	0.0
Y068-2	Inc. Y868-2	26.7	0.0	4.0	5.2	5.2	4.8	1.0	2.3	0.0
Y068-4	Inc. Y868-4	26.3	3.9	14.0	15.2	15.2	4.9	1.0	3.7	0.0
Y068-6	Inc. Y868-6	27.3	10.8	15.7	25.7	29.2	3.8	1.0	2.8	1.2
Y069-13	Inc. Y869-13	28.0	1.2	4.8	7.2	7.2	4.6	2.0	2.8	0.0
Y069-18	Inc. Y869-18	28.0	1.2	3.6	8.3	8.3	4.2	1.7	5.8	0.0
Y069-26	Inc. Y869-26	26.7	3.2	5.4	7.7	7.7	5.9	2.0	4.5	0.0
R070-9	Inc. R070-9	26.0	0.0	2.7	4.0	4.0	3.9	1.7	7.0	0.0
R080-5	Inc. R880-5	25.3	0.0	1.3	6.6	6.6	7.1	2.0	1.5	0.0
R080-9	Inc. R880-9	27.7	0.0	0.0	0.0	0.0	5.8	1.7	5.5	0.0

TEST 301. EVALUATION OF SELECTED PROGENY LINES FOR NONBOLTING, SALINAS, CA, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting				Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	9/25	Mean	Score	Mean	%
Inc. FS progeny from MM,S^sS^s lines (cont.)										
R080-13	Inc. R880-13	26.7	0.0	0.0	2.4	2.4	7.0	2.0	2.0	0.0
R080/2-9	Inc. R880/2-9	26.7	0.0	1.2	6.2	8.6	6.4	2.0	1.3	0.0
R080/2-11	Inc. R880/2-11	28.3	1.1	1.1	1.1	1.1	3.9	1.7	2.7	0.0
R080-45-10	Inc. R880-45-10	28.3	1.2	1.2	1.2	2.4	2.1	2.0	1.0	0.0
Y067-3	Inc. Y867-3	27.7	11.9	23.9	27.5	28.7	5.3	2.3	5.0	0.0
Y072-4	Inc. Y872-4	27.0	0.0	0.0	8.6	9.9	6.0	1.7	1.2	0.0
Inc. S_1 progeny lines										
0931- 5	Inc. 8913- 5 (A,aa)	28.0	0.0	0.0	1.2	1.2	5.1	1.7	1.0	0.0
0931- 7	Inc. 8931- 7 (A,aa)	27.3	0.0	1.2	1.2	1.2	3.1	1.7	1.3	0.0
0935-25	Inc. 8935-25 (A,aa)	26.7	0.0	0.0	2.7	2.7	3.7	1.3	0.2	0.0
0936- 8	Inc. 8936- 8 (A,aa)	27.0	0.0	0.0	0.0	1.3	1.9	2.0	1.2	0.0
0936-10	Inc. 8936-10 (A,aa)	27.3	3.7	8.5	10.8	10.8	2.2	1.7	2.7	1.4
0936-11	Inc. 8936-11 (A,aa)	26.7	0.0	0.0	0.0	0.0	1.7	1.3	1.7	0.0
0936-16	Inc. 8936-16 (A,aa)	27.3	0.0	2.4	3.6	3.6	2.7	2.0	0.0	0.0
0934- 5	Inc. 8934- 5 (A,aa)	29.7	0.0	4.3	10.0	11.1	6.3	1.3	0.3	0.0
Z025-9	Z825-9aa x A	26.3	0.0	7.5	10.3	12.8	2.7	1.3	0.8	1.1
0929-112	8929-112aa x A	26.3	6.3	15.0	21.4	21.4	3.2	2.0	1.7	0.0
0929-114	8929-114aa x A	25.0	20.9	34.9	38.9	38.9	3.1	2.0	0.0	2.2
0930-19	8930-19aa x A	24.7	0.0	0.0	1.4	1.4	2.7	1.3	1.8	4.2
0927-29	8927-29aa x A	27.7	8.4	19.2	27.6	28.9	3.3	1.7	2.7	0.0
CR009-1	CR909-1aa x A	26.7	14.0	31.8	39.0	41.4	5.4	2.3	0.0	5.3
Mean		26.7	3.2	6.9	9.7	10.4	4.2	1.7	2.6	0.4
LSD (.05)		3.3	6.6	8.0	9.0	9.2	1.3	0.8	3.2	2.4
C.V. (%)		7.7	126.9	72.0	56.7	54.8	18.2	28.0	76.7	378.2
F value		5.0**	4.7**	9.8**	10.9**	11.2**	10.9**	5.2**	2.6**	1.8*

TEST 5101. EVALUATION OF PLANT INTRODUCTIONS (PI's), SALINAS, CA, 2001

48 entries x 4 reps, sequential
1-row plots, 11 ft. long

Planted: April 30, 2001
Rhizomania Scored: November 15, 2001

Variety	Description	Harvest Count No.	RZM Score DI	RZM Score %R	RZM Visual[1]	End Use Score	Mature Leaf Pigmentation Score	Petiole Color Score	Bolting without Induction Score
Plant Introductions (Beta vulgaris)									
Ames 8280	IDBBNR 9497	7.5	3.2	88.7	s	7	3	3	3
Ames 19161	Alasehirskaja	9.3	3.5	73.3	s	2	4	3	2
NSL 141994	043	15.0	4.0	47.2	s	5	1	1	2
PI 476322	Belocerkovskaja o	8.8	3.5	66.0	r	5	1	1	2
PI 531254	KAWEMAJA	8.0	4.1	43.1	s	2	3	3	2
Ames 3096	IDBBNR 4828	14.0	4.7	18.1	s	4	3	5	2
Ames 19022	IDBBNR 9554	13.8	3.5	72.5	s	2	3	3	2
Ames 19158	Kyzyl-ca	11.3	4.6	16.9	s	5	1	1	2
Ames 19160	Adanskaja Zeltaja	2.5	4.6	12.5	s	3	2	5	2
Ames 19162	Abhazskaja Zelena	13.3	4.0	48.3	s	2	3	3	2
Ames 19166	Ramonskaja 931	16.8	4.0	47.7	s	5	2	1	2
Ames 19167	Jaltuskovskaja Od	15.0	4.1	41.3	s	4	2	1	2
NSL 141995	1502HO/NB1 (CMS)	15.5	3.5	68.0	r	5	2	1	2
PI 612767	AT3986A	17.3	3.7	63.6	seg	4	2	1	2
PI 612770	EL40 Breeding Line	5.8	3.4	80.0	s	5	1	2	2
Plant Introductions (*Beta vulgaris* subsp. *maritima*)									
PI 504262	Wild beet	13.0	3.3	76.2	seg	6	3	5	3
PI 518306	IDBBNR 5800	6.3	3.2	87.5	r	6	2	2	2
PI 540676	WB 930	10.3	3.0	96.9	r	6	3	3	2
PI 518424	IDBBNR 5918	5.8	3.4	72.3	seg	6	3	3	2
PI 540606	WB 860	6.0	3.1	93.8	r	6	2	4	2
US H11	11-3-99. RZM susc ck.	16.8	3.7	56.5	s	5	2	1	2
7CG7322	Betaseed RzRz, 9-13-99	13.0	3.2	86.8	s	5	2	1	2
00-C37	Inc. U86-37, (C37)	15.5	4.0	42.5	s	5	2	1	2
97-SP22-0	Inc. SP7622-0, VY susc ck.	19.0	3.9	48.9	s	5	2	1	2

TEST 5101. EVALUATION OF PLANT INTRODUCTIONS (PI's), SALINAS, CA, 2001

(cont.)

Variety	Description	Harvest Count	RZM Score		RZM	End Use	Mature Leaf Pigmentation	Petiole Color	without Induction
		No.	DI	%R	Visual[1]	Score	Score	Score	Score
Checks and Observation (cont.)									
R021	RZM R926,R927,(C26,C27),(*Bvm*)	22.8	3.4	74.9	seg	5	2	1	2
R036	RZM R936, (C79-8,R22,*Bvm*)	17.3	3.5	68.1	r	5	2	1	2
0921	RZM 9926aa x R926,R927	18.8	3.3	79.0	seg	5	2	1	2
0926	RZM-%S 8926(Sp)	17.5	3.3	78.1	seg	5	2	1	2
0927-29	8927-29aa x A	10.8	3.4	76.2	--	5	2	1	2
0930-19	8930-19aa x A	17.0	3.5	67.4	r	5	2	1	2
Z025-9	Z825-9aa x A	17.5	3.4	79.0	seg	5	1	1	2
0931	RZM 9931aa x A	17.3	3.5	62.8	seg	5	2	1	2
0941	RZM 9941aa x A	18.8	3.6	67.7	seg	5	2	1	2
9933	8933aa x A	20.3	3.5	74.5	r	5	2	1	2
0934	RZM 9934(A,aa)	17.5	3.3	78.5	seg	5	2	1	2
0942	RZM-% R576-89-18H18,19	15.8	3.2	84.7	s	5	2	2	2
Beta 4776R	4-13-01	15.5	3.5	72.7	r	5	2	1	2
Beta 6600	7-11-00	19.8	3.3	80.3	r	5	2	1	2
Monohikari	Seedex 4-16-99	20.3	3.9	52.0	seg	5	2	1	2
Crystal 205	3-1-00	17.5	3.4	75.9	s	5	2	1	2
Y090	Inc. FS progeny sel.	20.5	3.5	69.0	seg	5	2	1	2
Y067	RZM Y967	19.3	3.3	76.5	r	5	2	1	2
Y075	RZM-% Y875	19.5	3.3	80.6	seg	5	2	1	2
R039	Inc. R539 (C39R)	16.5	3.3	77.3	seg	5	2	1	2
P012	PMR-RZM P912	18.0	3.5	70.8	r	5	1	1	2
P007/8	PMR-RZM P807-2,-8; P808-7	16.8	3.3	77.4	seg	5	2	1	2
N024	RZM N925,N926,…-#(C)(g)(A,aa)	16.5	3.2	83.7	seg	5	2	1	2
CR009-1	RZM CR909-1aa x A	19.5	3.1	89.2	seg	5	2	2	2

TEST 5101. EVALUATION OF PLANT INTRODUCTIONS (PI's), SALINAS, CA, 2001

(cont.)

Variety	Description	Harvest Count No.	RZM Score DI	RZM Score %R	RZM Visual[1]	End Use Score	Mature Leaf Pigmentation Score	Petiole Color Score	without Induction Score
Mean		14.8	3.6	67.6	--	4.8	1.9	1.6	2.0
LSD (.05)		4.1	0.5	22.4	--	0.7	0.7	1.1	0.3
C.V. (%)		19.7	9.2	23.7	--	10.7	26.5	45.9	11.8
F value		10.7**	5.8**	5.8**	--	16.6**	6.0**	7.7**	1.0NS

Notes: Test replanted June 19, 2001 resulting in small plants. Test variable. Soil variable. Rhizomania development and severity variable. DI = disease index, where individual plants scored on a scale of 0 to 9 where 9 = dead. %R = % resistant where classes 0-3 were considered resistant.

[1] Visual evaluation to rhizomania (rzm) based upon foliar color (yellowing), vigor, etc., where r = resistant, s = susceptible, seg = segregating.

End Use was based upon field appearance where: 1 = chard; 2 = DDR-like; 3 = DDR,chard,spinach; 4 = fodder 5 = sugar; 6 = wild beet type; 7 = mixed.

Mature Leaf Blade Pigmentation where: 1 = light green (chard); 2 = green; 3 = red & green; 4 = red; 5 = mutant.

Petiole Color where: 1 = green; 2 = pink; 3 = red; 4 = candy stripe; 5 = yellow; 6 = mixed.

Bolting Tendency without cold induction where: 1 = B_(annual) 100%; 2 = bb(biennial) 0%; 3 = B:bb(mixed) 1-99%.

CONCLUSION: Based upon known reactions to rhizomania of some of these entries, data for rhizomania are not valid or useful. However, by both root and foliar symptoms, PI's 518306, 540676, 518424, and 540606 are most likely highly resistant.

EVALUATION OF PAIRCROSSES (FULL SIBS) OF LINES WITH Bvm GERMPLASM, SALINAS, 2001

(TESTS 1501, 501, B801, B1201)

	Test 1501(VY)					Test 501(NB)			Test B801(RZM)			Test B1201
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seq Rating	% Bolting 9/25	Downey Mildew Mean	Root Rot %	Sugar Yield Lbs	Sucrose %	Appear Score Mean	Appearance Score Mean
Checks												
Y075	18411	18.20	85.7	4.3	2	16.9	1.5	0.0	7238	15.10	1.8	2.3
Y067	18343	18.37	86.9	4.0	2	40.6	1.2	0.0	7289	14.48	1.8	2.2
97-US75	14644	15.70	83.9	9.0	3	93.2	0.7	0.0				
Y072-4	15430	18.30	85.2	4.0	2	7.8	1.2	0.0				
Beta 4430R									9455	15.98	2.8	3.2
Phoenix									6281	14.27	2.8	3.5
US H11									6013	13.72	2.5	4.2
Y071									6855	13.49	2.0	3.2
99-C31/6									6831	14.68	2.5	
Y090									8145	14.56	2.0	
Y075-# = RZM Y975(PX)												
Y075 - 1	16093	17.40	86.1	8.3	3	7.5	1.5	0.0	7521	14.66	2.5	2.3
- 2	15774	17.10	84.1	9.0	3	8.3	1.2	0.0	7913	14.01	2.3	2.0
- 3	18659	18.50	86.8	8.2	3	20.6	1.3	0.0	5688	15.61	4.0	3.3
- 4	16091	17.47	85.2	8.8	3	11.0	1.2	0.0	6259	14.06	2.5	1.0
- 5	16395	17.90	83.1	7.3	3	0.0	2.7	0.0	7016	15.28	2.3	
- 6	14775	17.97	85.2	7.3	2	2.0	1.2	2.0	3527	15.85	4.0	
- 7	15105	16.33	87.7	9.0	3	2.4	2.8	0.0	7440	14.01	2.5	
- 8	14937	17.37	86.2	8.2	3	0.0	2.3	2.2	4247	15.68	3.5	
- 9	17102	18.47	86.8	8.8	3	4.8	1.5	0.0	7756	15.02	2.8	
-10	15794	18.03	84.4	8.5	3	28.1	3.7	0.0	5030	14.88	3.8	
-11	18276	17.33	84.3	5.7	2	77.7	1.7	0.0	5379	12.74	3.3	
-12	15330	16.93	85.0	6.3	2	11.1	4.7	0.0	6640	15.01	2.8	

EVALUATION OF PAIRCROSSES (FULL SIBS) OF LINES WITH Bvm GERMPLASM, SALINAS, 2001

(TESTS 1501, 501, B801, B1201)

	Test 1501(VY)					Test 501(NB)			Test B801(RZM)			Test B1201
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seq Rating	% Bolting 9/25	Downey Mildew Mean	Root Rot %	Sugar Yield Lbs	Sucrose %	Appear Score Mean	Appearance Score Mean
Y075-# = RZM Y975(PX) (cont.)												
Y075 -13	16151	17.33	89.3	7.7	3	4.8	1.8	0.0	3751	15.25	3.5	
-14	14748	18.47	86.8	9.0	3	65.6	3.3	0.0	4979	14.76	3.8	
-15	17388	18.00	84.1	6.3	3	34.6	0.5	0.0	3800	14.60	3.3	
-16	17800	18.60	86.5	9.0	3	9.6	1.2	0.0	6948	16.65	2.8	
-17	14110	18.23	84.8	4.0	2	32.2	1.3	2.6	5220	15.56	3.0	
-18	18282	18.10	85.4	6.2	2	22.6	1.5	2.4	8678	16.42	2.0	
-19	14538	18.53	87.6	5.3	2	24.5	0.7	0.0				4.3
Y067-# = RZM Y967(PX)												
Y067 - 1	17599	18.83	85.9	2.3	2	30.4	1.0	4.5	6957	15.89	1.8	2.0
- 2	16744	17.47	85.3	4.8	2	22.6	0.3	8.6	5975	14.63	2.8	2.8
- 3	16057	18.17	86.8	5.7	2	64.7	0.8	2.6	7821	16.15	2.0	2.3
- 4	17384	18.23	87.1	4.2	2	15.5	1.8	0.0	6922	14.24	2.0	2.0
- 5	15862	18.00	81.7	3.3	2	46.9	0.7	6.8	8734	15.68	1.5	
- 6	18020	18.67	86.9	3.8	2	22.8	0.7	2.8	5786	15.05	2.5	
- 7	16633	17.47	89.4	3.8	2	33.6	1.2	0.0	5731	12.94	2.3	
- 8	17462	18.70	88.9	4.8	2	46.3	1.2	2.1	5707	15.47	3.0	
- 9	18399	18.23	87.2	2.8	2	75.0	1.5	0.0	10289	15.16	1.8	
-10	15301	17.37	83.5	2.5	2	27.4	0.5	0.0	7763	16.38	1.8	
-11	15425	17.50	87.5	3.7	2	93.0	0.5	2.4	6284	15.68	2.3	
-12	16078	17.97	87.5	6.0	2	80.1	0.8	0.0	9544	16.92	2.3	
-13	14844	17.93	83.3	3.5	2	50.7	0.8	0.0	8133	15.41	2.3	

EVALUATION OF PAIRCROSSES (FULL SIBS) OF LINES WITH Bvm GERMPLASM, SALINAS, 2001

(TESTS 1501, 501, B801, B1201)

	Test 1501(VY)					Test 501(NB)			Test B801(RZM)			Test B1201
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seq Rating	% Bolting 9/25	Downey Mildew Mean	Root Rot %	Sugar Yield Lbs	Sucrose %	Appear Score Mean	Appearance Score Mean
Y067-# = RZM Y967(PX) (cont.)												
Y067 -14	17304	17.30	86.8	5.5	2	38.5	0.3	2.4	8631	15.41	2.8	
-15	17188	17.77	83.9	5.0	2	71.4	0.3	0.0	9554	17.42	1.5	
-16	15421	17.93	86.9	5.3	2	68.1	0.7	0.0	6776	15.49	2.5	
-17	14703	16.93	88.1	2.2	2	40.7	1.2	8.5	4947	14.00	3.5	
-18	17788	17.77	87.1	6.5	2	39.7	0.5	2.1	8917	14.82	1.8	
-19	15316	18.27	84.9	5.8	2	46.7	2.5	0.0	6885	16.49	3.0	
-20	15587	17.67	86.0	5.5	2	21.4	1.2	0.0	6303	16.09	2.8	
-21	17343	18.33	86.6	3.2	2	51.1	2.0	2.4	9329	16.99	1.8	
-22	15544	18.10	88.3	3.8	2	33.7	2.3	0.0	5159	16.24	3.3	
-23	16515	17.47	88.4	4.2	2	41.9	2.7	0.0	6721	14.66	3.0	
-24	14780	18.00	88.3	5.0	2	2.2	1.5	0.0	7815	16.11	1.5	
-25	13980	17.33	86.4	4.8	2	14.8	2.7	0.0	7748	15.83	2.0	
Checks												
Y067	17704	18.30	86.6	4.3	2	30.9	1.8	0.0				
Y075	15541	18.10	87.6	5.5	2	24.2	3.0	0.0				
Y071	15109	17.37	86.9	8.0	3	7.8	3.8	2.2				
00-SP22-O	14100	16.17	85.2	6.2	2	100.0	1.8	0.0				
Y067-# = RZM Y967(PX) (cont.)												
Y067 -26	17803	18.00	87.3	0.7	1	5.2	1.3	0.0	6944	16.80	3.0	
-27	15304	16.27	84.7	3.7	2	17.2	2.0	2.2	9431	15.26	1.8	
-28	19542	18.60	87.1	8.2	3	46.7	2.0	0.0	6067	16.72	2.5	
-29	16801	17.37	83.3	3.3	2	72.4	0.5	2.4	8818	14.38	2.8	

EVALUATION OF PAIRCROSSES (FULL SIBS) OF LINES WITH Bvm GERMPLASM, SALINAS, 2001

(TESTS 1501, 501, B801, B1201)

Variety	Test 1501(VY) Sugar Yield Lbs	Test 1501(VY) Sucrose %	Test 1501(VY) RJAP %	Test 1501(VY) Powdery Mildew Score	Test 1501(VY) PM Seg Rating	Test 501(NB) % Bolting 9/25	Test 501(NB) Downey Mildew Mean	Test 501(NB) Root Rot %	Test B801(RZM) Sugar Yield Lbs	Test B801(RZM) Sucrose %	Test B801(RZM) Appear Score Mean	Test B1201 Appearance Score Mean
Y067-# = RZM Y967(PX) (cont.)												
Y067 -30	15542	17.30	86.7	5.2	2	41.0	1.8	0.0	9881	15.40	2.0	
-31	18238	17.13	85.0	3.5	2	27.9	0.5	2.1				3.0
-32	17154	17.97	86.1	6.0	2	60.6	1.2	0.0				2.3
-33	14618	17.97	85.9	5.2	2	30.5	2.0	0.0				3.3
-34	19295	18.77	87.1	5.2	2	50.7	0.5	0.0				2.0
-35	17423	17.60	86.7	5.0	2	22.1	1.5	0.0				1.8
Y071-# = RZM Y971(PX)												
Y071 - 1	14528	18.03	83.0	9.0	3	0.0	1.8	0.0	5992	16.42	2.8	2.5
- 2	18883	18.93	88.5	9.0	3	60.5	1.7	0.0	6723	16.02	2.3	3.0
- 3	16407	17.53	88.0	9.0	3	57.6	1.5	0.0	4709	13.76	4.0	3.0
- 4	16672	18.03	87.3	8.5	3	56.3	1.7	2.1	6622	14.59	2.3	3.0
- 5	18164	17.97	87.2	8.0	3	23.5	0.3	0.0	8462	16.03	2.8	
- 6	16126	19.00	84.4	8.8	3	2.6	1.0	0.0	6133	16.38	2.8	
- 7	17840	18.03	83.6	8.7	3	58.5	0.7	0.0	8999	15.09	1.5	
- 8	17403	17.60	87.3	7.8	3	32.3	2.3	0.0	7960	14.98	3.3	
- 9	17182	17.57	87.1	7.7	3	41.4	0.3	0.0	7124	14.10	2.5	
-10	19297	18.70	86.3	8.8	3	2.6	2.3	0.0	6102	16.06	2.8	
-11	17667	17.30	84.8	8.2	3	2.1	1.8	0.0	6617	14.72	3.0	
-12	17197	18.03	87.8	9.0	3	8.8	0.7	0.0	6722	15.44	2.3	
-13	16435	18.40	88.0	8.5	3	19.1	0.3	0.0	7329	16.28	2.3	
-14	17759	18.77	86.1	8.8	3	6.3	0.3	0.0	6620	17.06	2.0	
-15	14784	16.97	83.6	8.8	3	15.5	1.0	0.0	5196	14.59	2.0	
-16	15350	16.97	85.1	7.7	3	7.0	3.0	0.0	9143	16.16	2.5	

EVALUATION OF PAIRCROSSES (FULL SIBS) OF LINES WITH Bvm GERMPLASM, SALINAS, 2001

(TESTS 1501, 501, B801, B1201)

	Test 1501(VY)					Test 501(NB)			Test B801(RZM)			Test B1201
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seq Rating	% Bolting 9/25	Downey Mildew Mean	Root Rot %	Sugar Yield Lbs	Sucrose %	Appear Score Mean	Appearance Score Mean
Y071-# = RZM Y971(PX) (cont.)												
Y071 -17	16312	17.47	86.8	7.2	3	0.0	1.0	0.0	4444	14.75	3.5	
-18	16012	17.73	86.5	8.3	3	46.8	0.8	0.0	6121	15.54	3.3	
-19	14358	17.37	86.0	6.5	2	34.5	1.8	0.0				3.3
-20	16180	17.13	85.9	7.7	3	0.0	1.2	0.0				2.3
R043-# = RZM R943												
R043 - 1	18747	17.33	86.1	7.0	2	22.6	2.2	2.2	9478	16.26	2.5	2.5
- 2	18605	17.30	83.6	8.8	3	19.0	1.8	0.0	5975	15.49	3.3	4.0
- 3	18517	17.60	85.9	8.7	3	49.6	1.2	0.0	7409	16.02	3.0	3.0
- 4	18128	18.53	87.0	8.8	3	64.8	0.8	2.2	7690	15.22	2.3	
- 5	16839	18.47	87.0	4.7	2	67.2	1.0	2.1	4629	15.33	3.3	
- 6	18306	18.10	87.4	9.0	3	49.5	0.8	0.0	6935	16.28	3.3	
- 7	17219	18.07	84.9	6.5	2	45.1	1.3	0.0	6275	15.28	2.8	
- 8	19207	17.50	88.4	7.3	2	34.6	2.2	0.0	7975	15.05	3.8	
- 9	16917	16.40	86.0	7.7	3	39.8	0.7	0.0	7642	14.44	3.3	
-10	15593	15.73	81.9	4.8	2	91.6	0.7	0.0	7106	14.62	3.3	
-11	16500	17.23	85.3	7.3	3	22.3	0.5	0.0	7126	16.41	3.3	
-12	18075	17.70	85.9	5.8	2	98.6	0.3	0.0	6486	15.40	3.5	
-13	16964	17.77	83.8	3.3	2	45.1	0.7	0.0	6918	15.90	2.5	
-14	18020	18.60	88.2	1.8	2	43.6	0.8	0.0	6608	16.44	3.3	

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C69 & R70, SALINAS, 2001

(TESTS 1601 and 601)

Variety	Test 1601 (VY)					Test 601 (NB)			
	Sugar Yield	Sucrose	RJAP	Powdery Mildew	PM Seg	% Bolting	Powdery Mildew	Downey Mildew	Root Rot
	Lbs	%	%	Score	Rating	9/25	Mean	%	%
Checks									
Y969(Iso)	18173	18.53	87.5	3.3	2	47.2	5.3	1.7	0.0
Y090	18083	18.67	87.1	6.3	2	8.2	5.8	1.8	0.0
00-SP22-0	12577	15.60	91.7	5.8	2	87.6	5.8	1.3	0.0
R970	18290	17.87	87.5	7.0	2	6.6	5.0	3.3	0.0
Y069-# = RZM Y969(PX)									
Y069 - 1	17098	18.07	89.3	7.5	2	17.1	6.3	1.0	0.0
- 2	16728	18.50	87.6	4.3	2	12.6	5.8	2.5	0.0
- 3	20365	18.03	88.5	2.0	2	25.3	5.7	0.7	1.9
- 4	18119	19.17	86.9	0.0	2	15.6	2.3	1.3	0.0
- 5	16304	18.40	87.7	1.2	2	82.6	6.0	1.5	0.0
- 6	16515	18.10	88.0	5.2	2	38.8	5.9	1.7	0.0
- 7	17111	18.73	86.9	3.5	2	5.1	6.0	1.7	0.0
- 8	16498	19.70	86.9	5.5	2	4.2	6.3	4.5	0.0
- 9	19061	17.90	87.1	1.7	1	73.4	2.9	2.3	2.2
-10	17988	18.60	87.7	2.2	1	21.1	5.6	0.5	11.9
-11	18056	18.03	88.2	4.7	2	61.0	5.4	0.2	2.6
-12	17719	18.43	86.7	3.7	2	40.4	6.3	1.3	2.2
-13	17417	18.27	88.2	1.0	1	16.1	5.4	1.7	2.1
-14	18011	18.20	86.6	4.8	2	24.2	5.0	0.3	6.5
-15	17200	19.03	88.2	2.0	2	49.2	3.4	2.5	0.0
-16	18377	18.20	89.7	0.7	1	72.5	4.6	1.8	0.0
-17	16977	18.77	85.3	3.7	2	37.7	5.1	0.7	0.0
-18	19317	18.90	89.3	4.2	2	6.4	5.4	2.5	0.0
-19	17167	17.93	85.9	4.8	2	21.6	5.6	1.2	0.0
-20	17227	17.80	87.9	0.0	1	26.1	3.4	1.3	2.6

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C69 & R70, SALINAS, 2001

(TESTS 1601 and 601)

(cont.)

Variety	Test 1601 (VY) Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seg Rating	Test 601 (NB) % Bolting 9/25	Powdery Mildew Mean	Downey Mildew %	Root Rot %
Y069-# = RZM Y969(PX) (cont.)									
Y069 -21	19773	18.53	88.5	5.8	2	37.0	5.6	2.7	0.0
-22	19152	18.70	87.3	2.5	2	49.0	4.8	2.5	4.2
-23	17076	17.47	87.5	1.3	2	30.6	2.1	1.2	4.6
-24	17014	18.03	87.8	0.5	1	52.7	2.8	0.8	2.2
-25	15404	18.47	88.8	4.3	2	0.0	4.4	3.0	0.0
-26	15623	17.70	90.7	8.0	3	34.4	5.7	0.5	2.2
-27	19216	18.43	88.6	2.7	2	22.4	3.7	1.3	2.4
-28	16139	18.30	88.3	1.8	2	17.1	4.1	1.7	0.0
-29	17517	18.53	89.1	0.8	1	57.5	4.1	0.3	7.9
-30	15559	18.10	88.2	1.5	2	14.0	5.0	3.2	0.0
-31	17212	18.60	86.8	4.8	2	20.2	6.1	1.7	0.0
-32	17359	19.50	89.1	3.0	2	45.6	6.1	0.7	2.2
-33	17292	18.07	87.3	2.0	2	6.8	3.9	2.5	2.4
-34	19470	18.30	89.0	4.2	2	26.3	5.3	0.7	0.0
-35	18607	18.40	89.2	1.2	1	21.5	3.4	3.2	1.8
-36	17061	18.47	86.0	3.8	2	61.8	6.6	0.3	2.1
-37	17687	17.90	87.7	3.3	2	26.7	5.6	0.3	2.2
-38	16199	17.77	89.1	4.5	2	3.9	2.7	2.3	0.0
-39	18766	18.97	94.4	0.3	2	23.7	3.1	1.8	2.1
-40	19108	18.50	90.6	3.5	2	33.8	4.8	3.8	0.0
-41	15627	18.17	88.8	4.0	2	17.3	6.2	1.5	0.0
-42	15317	17.70	87.2	6.0	2	27.1	5.8	1.3	9.1
-43	15743	17.83	88.3	5.7	2	63.1	6.2	1.5	2.1
-44	15229	17.53	86.4	0.0	1	57.7	4.7	1.0	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C69 & R70, SALINAS, 2001

(TESTS 1601 and 601)

(cont.)

Variety	Test 1601 (VY) Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seg Rating	Test 601 (NB) % Bolting 9/25	Powdery Mildew Mean	Downey Mildew %	Root Rot %
Checks									
Y969(Iso)	16358	17.47	86.8	3.5	2	34.4	5.7	2.8	0.0
Y090	17151	17.90	87.0	5.5	2	10.3	5.7	2.5	0.0
Y069-13	18030	18.63	88.5	3.0	2				
Y068-1	13923	17.63	88.0	6.0	2	8.5	6.1	4.2	0.0
97-SP22-0						91.6	5.7	0.3	0.0
Y069 -45	18200	17.37	88.5	1.2	2	57.3	4.6	1.5	0.0
-46	15754	19.27	90.9	2.7	2	39.5	6.2	1.0	2.6
-47	19678	17.97	88.4	8.3	3	13.7	6.3	2.2	0.0
-48	18619	17.50	87.3	4.7	2	60.7	4.7	1.3	0.0
-49	16757	17.90	85.9	0.3	1	71.6	4.2	1.8	0.0
-50	18586	18.37	86.2	2.3	2	15.4	2.9	2.3	2.1
-51	18106	18.73	88.2	0.8	1	41.7	4.8	0.3	2.4
-52	18252	18.87	87.7	0.2	1	67.8	4.9	1.5	0.0
-53	18650	18.27	85.8	0.7	2	42.5	5.3	0.5	2.2
-54	18245	17.87	89.0	5.5	2	56.6	6.0	1.5	5.1
-55	16328	18.30	86.5	1.0	1	49.1	4.9	0.3	0.0
-56	18290	17.73	87.2	3.8	2	76.3	5.2	1.3	2.1
-57	17205	18.20	89.2	1.3	2	2.4	4.6	1.8	0.0
-58	17987	18.00	85.9	1.2	1	41.2	3.9	1.5	0.0
-59	15802	17.50	83.3	4.7	2	29.9	4.9	0.8	3.9
-60	17635	19.10	86.9	1.3	1	75.7	5.2	0.0	2.2
-61	17335	18.07	86.4	6.3	2	23.7	4.3	1.8	0.0
-62	16300	18.47	87.1	0.8	1	81.8	2.8	1.3	2.0
-63	19932	19.13	87.5	1.0	1	47.6	5.1	2.2	0.0
-64	16876	18.27	88.0	1.5	1	63.9	4.6	0.5	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C69 & R70, SALINAS, 2001

(TESTS 1601 and 601)

(cont.)

	Test 1601 (VY)					Test 601 (NB)			
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	PM Seg Rating	% Bolting 9/25	Powdery Mildew Mean	Downey Mildew %	Root Rot %
Y069 -65	19114	18.33	85.2	3.2	2	24.5	4.2	0.2	0.0
-66	17536	18.13	84.2	0.0	1	42.6	4.6	1.0	10.2
-67	19127	18.73	87.8	5.8	2	36.6	7.3	0.5	4.2
-68	19690	19.10	89.1	0.5	2	84.2	5.2	0.3	2.6
-69	15129	18.07	86.0	4.7	2	74.5	5.7	0.5	0.0
-70	19400	18.80	90.0	3.0	2	24.2	5.0	0.3	2.4
R070-# = RZM R970(PX)									
R070 - 1	18375	17.63	87.4	7.0	2	16.5	4.9	2.0	0.0
- 2	19282	17.23	87.3	7.7	2	35.6	5.0	1.0	0.0
- 3	17091	18.93	87.8	4.5	2	7.0	3.9	2.0	0.0
- 4	13629	14.80	83.0	6.3	2	2.4	4.6	3.5	0.0
- 5	19169	18.43	87.5	6.7	3	15.9	4.7	4.3	0.0
- 6	16143	17.47	84.8	5.3	2	50.8	3.3	3.0	0.0
- 7	17806	16.53	85.4	7.2	2	4.4	5.0	1.0	0.0
- 8	18257	18.27	87.2	6.0	2	0.0	5.7	1.8	0.0
- 9	17792	17.43	87.5	6.7	2	7.8	3.4	2.0	0.0
-10	14672	15.90	80.9	7.2	3	17.2	4.4	3.7	0.0
-11	17549	17.37	86.1	8.0	3	2.2	4.6	2.0	0.0
-12	16594	17.87	92.6	4.7	2	0.0	4.3	1.2	0.0
-13	17120	17.93	85.7	7.3	2	0.0	5.3	0.2	0.0
-14	18475	16.70	85.4	4.8	2	0.0	3.9	0.8	0.0
-15	15683	18.47	87.3	5.3	2	0.0	5.2	2.2	0.0
-16	19039	18.43	87.6	7.0	2	69.7	5.8	1.3	0.0
-17	15105	17.13	86.7	8.7	3	9.9	5.8	1.8	0.0
-18	17933	19.23	88.5	5.2	2	0.0	5.4	0.8	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, 2001

(TESTS 1701 and 701)

Variety	Test 1701 (VY)				Test 701 (NB)			
	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	Powdery Mildew	Downey Mildew	Root Rot
	Lbs	%	%	Score	9/25	Mean	%	%
Checks								
R078(Iso)	16452	17.60	87.3	2.8	20.6	5.2	2.8	0.0
R980	17113	18.30	88.3	5.2	20.5	5.1	1.0	0.0
97-US22/3	13114	18.17	90.0	9.0	98.1	5.7	1.5	0.0
00-C37	11461	16.17	88.2	9.0	7.9	7.2	1.5	0.0
R078-# = RZM R978(PX)								
R078 - 1	19413	17.83	87.4	5.2	96.1	5.3	1.3	0.0
- 2	16545	18.77	88.0	5.3	2.4	5.3	3.3	0.0
- 3	15406	17.93	86.3	6.8	0.0	5.8	2.2	0.0
- 4	15349	17.60	88.2	6.7	4.4	5.7	2.3	0.0
- 5	16281	18.03	87.5	4.0	7.5	4.2	3.3	0.0
- 6	17554	17.77	88.7	3.3	16.0	4.0	1.8	0.0
- 7	18521	18.57	88.7	5.0	2.4	5.2	2.7	0.0
- 8	17446	18.03	88.0	1.2	36.9	3.7	3.5	4.2
- 9	17291	17.87	88.7	4.0	9.5	4.1	2.2	2.8
-10	14808	17.23	90.1	5.5	35.0	4.7	1.5	0.0
-11	15113	17.27	86.2	4.7	2.6	4.8	2.7	0.0
-12	16970	18.27	86.7	1.5	30.4	6.1	2.8	0.0
-13	16982	17.57	88.6	1.7	0.0	5.3	4.2	0.0
-14	17556	18.80	86.1	2.2	2.2	5.1	1.5	0.0
-15	15189	18.10	88.3	3.3	22.8	5.4	1.8	2.2
-16	17182	18.90	88.3	0.5	14.0	3.6	0.8	0.0
-17	16694	18.07	87.2	2.7	69.8	4.1	1.7	0.0
-18	15980	17.93	87.0	2.7	0.0	4.1	1.0	0.0
-19	17820	17.80	89.7	2.2	47.0	3.4	2.2	0.0
-20	18046	17.57	87.7	1.7	50.4	4.7	1.7	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, 2001

(TESTS 1701 and 701)

(cont.)

Variety	Test 1701 (VY) Sugar Yield Lbs	Test 1701 (VY) Sucrose %	Test 1701 (VY) RJAP %	Test 1701 (VY) Powdery Mildew Score	Test 701 (NB) % Bolting 9/25	Test 701 (NB) Powdery Mildew Mean	Test 701 (NB) Downey Mildew %	Test 701 (NB) Root Rot %
R078 -21	17110	17.37	85.0	0.8	29.8	3.8	1.0	0.0
-22	15855	17.53	88.5	0.2	56.0	4.9	1.2	0.0
-23	15724	17.37	86.7	2.5	30.9	3.6	2.3	0.0
-24	16064	16.97	85.2	0.0	61.1	3.0	1.0	0.0
-25	14289	17.47	87.4	4.3	0.0	5.3	2.3	0.0
-26	14509	17.30	89.8	6.0	4.4	4.9	2.2	0.0
-27	16371	18.57	88.5	1.8	2.4	4.7	1.5	0.0
-28	17331	18.63	87.5	1.8	34.5	5.0	1.8	0.0
-29	17618	18.23	90.0	3.3	9.9	5.0	0.5	0.0
-30	17141	17.67	86.9	1.2	25.7	3.4	1.0	0.0
-31	15475	16.97	87.8	0.5	4.8	3.2	3.0	0.0
-32	15539	18.53	88.0	2.0	4.9	4.1	2.8	0.0
-33	16877	18.50	88.9	1.3	22.5	4.8	1.8	0.0
-34	15226	17.93	86.9	0.5	60.1	4.1	1.2	0.0
-35	16938	17.40	89.1	2.7	0.0	5.9	2.0	0.0
-36	16806	17.77	86.3	2.2	3.3	4.0	1.8	0.0
-37	16063	17.93	88.6	1.8	0.0	3.0	0.8	5.9
-38	13503	17.43	88.0	2.0	0.0	3.1	0.3	0.0
-39	15614	17.77	85.3	2.0	6.7	3.9	1.2	3.3
-40	17444	17.97	87.6	1.3	5.8	4.0	0.5	0.0
R080-# = RZM R980(PX)								
R080 - 1	17567	18.57	87.7	4.7	71.0	4.4	1.8	2.1
- 2	16285	18.27	86.8	7.7	38.9	4.9	1.7	0.0
- 3	14980	17.00	90.1	9.0	2.6	5.6	1.0	2.6
- 4	14931	18.73	88.6	7.2	15.7	5.4	0.2	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, 2001

(TESTS 1701 and 701)

(cont.)

	Test 1701 (VY)				Test 701 (NB)			
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 9/25	Powdery Mildew Mean	Downey Mildew %	Root Rot %
R080-# = RZM R980(PX)	(cont.)							
R080 - 5	17050	17.60	89.0	7.5	0.0	6.1	1.8	0.0
- 6	19450	18.47	89.3	5.2	15.5	4.2	0.5	7.0
- 7	15957	18.30	87.2	5.5	45.3	5.4	1.5	0.0
- 8	16932	17.90	86.5	5.7	37.1	4.8	0.7	0.0
- 9	16661	18.03	87.1	5.5	30.4	4.4	1.5	6.7
-10	16367	17.37	87.1	3.8	17.5	5.6	2.5	0.0
-11	15204	17.47	87.8	9.0	7.0	6.0	2.5	0.0
-12	16808	17.97	88.6	5.8	52.4	5.1	0.5	0.0
-13	18646	18.87	88.3	7.0	33.0	4.9	0.5	0.0
-14	17235	18.43	87.5	6.7	18.2	4.6	0.2	0.0
-15	14339	17.33	87.3	1.3	12.9	2.9	0.8	0.0
-16	18663	18.17	89.2	9.0	32.9	5.7	0.5	0.0
-17	16751	18.60	87.3	2.2	2.8	3.7	0.2	2.8
-18	18368	17.80	87.1	4.8	44.4	4.9	1.3	0.0
-19	17546	17.40	89.1	6.3	11.1	6.1	1.2	0.0
-20	18182	18.53	88.7	8.3	73.8	5.4	0.5	1.9

EVALUATION OF BACKCROSS FAMILIES (FS's) FROM POWDERY MILDEW, SALINAS, 2001

(TESTS 1801, 801, 4101, B1201)

Variety	Test 1801(VY) Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	Test 801(NB) % Bolting 9/25	Powdery Mildew Mean	Downey Mildew Mean	Root Rot %	Test 4101(PM) Powdery Mildew Mean	Test B1201(RZM) Appearance Score Mean
Checks										
P017	16793	17.77	89.0	6.3	43.3	4.9	2.7	0.0	5.2	3.7
P018	16739	17.30	85.8	4.7	53.0	4.2	2.8	0.0	4.2	2.2
P019	18640	17.67	88.8	4.3	39.2	4.2	2.5	0.0	3.7	2.3
P020	17061	17.70	85.6	5.7	62.1	4.0	4.0	0.0	4.5	3.5
00-C37	14377	17.37	86.3	8.7	0.0	6.2	2.2	2.1	6.9	3.8
R078(Iso)	16620	17.43	84.4	3.7	21.4	5.0	3.0	0.0	4.9	3.7
99-WB242	14261	16.97	87.8	5.0	34.4	3.7	1.8	0.0	3.0	
US H11	14144	15.23	86.5	9.0					6.7	4.2
97-US22/3					95.8	5.4	1.5	0.0		
P029-# = C78 x PMR-RZM P919-#(C)										
P029 - 1	16799	17.63	84.5	6.0	42.2	6.2	1.3	0.0	4.9	3.0
- 2	17329	18.70	84.4	3.7	6.3	5.4	1.3	0.0	4.7	3.0
- 3	19692	17.87	87.5	1.7	10.0	2.8	1.3	0.0	4.0	4.0
- 4	18342	18.10	86.2	2.7	9.5	5.4	2.7	0.0	3.9	3.0
- 5	17108	17.53	83.6	5.3	34.2	5.0	1.0	0.0	5.0	4.0
- 6	18883	17.70	86.1	4.3	32.3	4.7	0.7	6.1	5.9	3.0
- 7	17683	18.07	86.3	8.3	43.3	5.6	0.5	0.0	6.6	3.5
- 8	19635	18.73	85.6	3.0	17.0	2.9	2.0	0.0	1.1	3.5
- 9	17138	16.97	84.4	2.0	0.0	4.9	1.2	0.0	4.7	3.0
-10	17855	17.67	86.2	2.7	10.8	3.9	1.2	0.0	4.4	3.0
-11	17393	18.90	85.8	3.7	33.2	5.0	1.3	0.0	4.6	3.0
-12	18630	18.90	86.4	3.7	2.8	4.8	1.2	0.0	6.4	3.0
-13	17237	17.67	87.0	1.0	84.4	2.8	1.7	0.0	4.9	3.5
-14	16759	17.40	84.8	2.3	0.0	4.0	1.5	0.0	3.6	3.5

EVALUATION OF BACKCROSS FAMILIES (FS's) FROM POWDERY MILDEW, SALINAS, 2001

(TESTS 1801, 801, 4101, B1201)

(cont.)

	Test 1801(VY)				Test 801(NB)				Test 4101(PM)	Test B1201(RZM)
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 9/25	Powdery Mildew Mean	Downey Mildew Mean	Root Rot %	Powdery Mildew Mean	Appearance Score Mean
P029-# = C78 x PMR-RZM P919-#(C) (cont.)										
P029 -15	15985	17.47	86.5	2.7	0.0	3.3	1.3	0.0		3.5
-16	18999	18.60	87.1	2.3	17.9	4.0	0.8	3.0	3.6	3.5
P019	17702	17.50	84.2	3.7						
P029 -19	16169	17.63	86.0	1.3	49.3	3.6	1.5	0.0		4.0
-20	20383	18.33	84.6	2.7	20.2	3.6	1.3	0.0	3.6	2.5
-21	13714	17.03	84.0	4.0	0.0	3.8	1.3	0.0	4.7	3.5
P030-# = C78 x PMR-RZM P920-#(C)										
P030 - 1	17557	18.43	83.5	3.0	43.3	5.4	0.8	0.0	4.4	3.0
- 2	18452	18.23	83.9	1.7	35.1	2.3	2.2	0.0	0.9	4.0
- 3	17086	17.47	84.6	3.3	48.3	3.4	0.7	0.0	2.9	4.0
- 5	16038	18.30	84.5	0.7	65.5	3.2	0.7	0.0	1.9	3.0
- 6	17997	18.60	87.3	2.7	38.8	3.7	2.2	0.0	2.9	3.5
- 7	17761	18.57	86.5	1.0	54.0	3.3	2.2	0.0	3.3	3.5
- 8	15823	17.93	83.4	1.7	60.6	4.9	2.0	0.0	4.7	3.0
- 9	29823	18.07	84.7	3.7	36.9	5.8	1.3	0.0	4.6	3.5
-10	19155	18.43	86.7	2.7	12.3	3.6	1.3	0.0	2.4	4.5
-11	18160	17.93	85.1	0.3	9.9	3.9	1.2	0.0	2.9	4.0
-12	17203	17.80	83.8	4.7	54.8	3.8	2.8	0.0	4.6	3.5
-13	16687	18.03	84.1	2.0	67.4	2.3	1.0	0.0	2.0	3.0
-14	18878	17.70	84.4	2.0	45.5	3.2	0.7	0.0	2.3	4.5
P020	16655	17.80	85.4	4.0						
P030 -16	17737	18.2	84.	6.0	14.1	4.1	1.5	0.0		3.5
-17	19570	18.53	85.4	4.3	0.0	4.2	1.0	0.0		

EVALUATION OF BACKCROSS FAMILIES (FS's) FROM POWDERY MILDEW, SALINAS, 2001

(TESTS 1801, 801, 4101, B1201)

(cont.)

	Test 1801(VY)				Test 801(NB)				Test 4101(PM)	Test B1201(RZM)
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 9/25	Powdery Mildew Mean	Downey Mildew Mean	Root Rot %	Powdery Mildew Mean	Appearance Score Mean
P030-# = C78 x PMR-RZM P920-#(C) (cont.)										
P030 -18	18564	18.57	86.0	4.3	11.1	4.1	1.3	0.0	4.6	4.5
-19	18091	18.30	87.8	3.7	36.8	3.8	0.7	2.6	4.3	4.5
-20	16960	18.30	86.1	2.0	14.1	3.3	0.0	0.0	2.7	
-22	18943	17.80	85.1	4.7	93.8	4.1	1.0	0.0	3.9	
P027-# = C37 x PMR-RZM P917-#(C),(WB97)										
P027 - 1	15501	18.27	86.7	9.0	58.3	6.1	0.5	2.1	6.3	
- 2	15694	17.50	87.7	9.0	0.0	6.1	2.5	0.0	6.6	
- 3	17439	17.33	83.6	6.7	17.8	4.6	0.8	2.2	6.0	
- 4	16427	17.23	85.9	7.7	15.6	4.3	0.7	2.4	6.9	
- 5	15666	16.97	83.7	7.3	52.5	4.1	0.3	5.1	5.3	
- 7	14766	17.03	90.7	7.7	12.5	4.8	2.3	5.1	5.9	
- 9	15296	17.13	84.0	9.0	60.6	6.2	0.3	0.0	7.9	
-10	14769	17.17	84.7	9.0	22.8	6.4	2.0	2.4	6.7	
P028-# = C37 x PMR-RZM P918-#(C),(WB242)										
P028 - 1	17467	17.73	87.7	7.7	32.6	5.6	1.3	2.2	6.6	
- 2	16744	17.37	87.0	7.7	44.9	4.4	0.5	2.4	4.1	
- 4	18459	17.70	86.8	7.3	53.1	5.2	1.5	0.0	4.6	
- 7	17529	17.70	83.9	7.7	47.8	5.3	0.7	10.3	5.7	
- 8	17126	18.33	86.8	9.0	0.0	6.2	0.8	4.2	6.6	
-10	21042	18.17	86.7	9.0	10.6	5.8	0.3	6.7	7.0	
-12	17492	17.47	84.8	6.7	8.1	4.3	1.7	0.0	6.1	
-15	18282	17.90	86.6	8.7	27.9	4.9	0.8	0.0	5.9	

EVALUATION OF S_1 PROGENY FROM SELF-FERTILE, MULTIGERM, RANDOM-MATED POPULATIONS, SALINAS, CA, 2001

(TESTS 1901 and 901)

	Test 1901 (VY)				Test 901 (NB)				
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	Powdery Mildew	Downey Mildew	Root Rot	Stand Count
	Lbs	%	%	Score	9/25	Mean	%	%	No.
Checks									
0931	18048	17.17	86.8	3.3	34.9	3.9	3.7	2.1	15.3
0941	17777	17.97	89.6	4.0	37.6	3.3	2.2	4.5	15.0
0930-19	19241	17.53	85.9	0.7	0.0	3.6	1.7	0.0	15.3
Z025-9	16241	19.63	85.4	2.7					
00-C37					9.9	6.2	2.3	0.0	17.0
0931-# = RZM 9931⊗									
0931 - 1	15260	16.90	86.8	3.3	23.5	3.9	1.7	2.4	14.3
- 2	17168	16.50	84.4	0.7	0.0	2.3	3.0	0.0	16.3
- 3	19098	17.93	87.1	0.0	9.2	1.8	1.5	2.4	14.7
- 4	15642	17.63	87.0	5.3	2.2	5.3	2.2	2.1	15.7
- 5	14282	18.33	84.5	4.0	0.0	4.4	1.8	0.0	15.7
- 6	13458	16.97	84.8	4.3	16.4	5.1	2.2	0.0	11.7
- 7	17452	17.40	82.8	0.3	4.4	1.8	2.7	0.0	14.0
- 8	14915	17.57	86.3	3.7	0.0	2.1	2.3	8.6	12.0
- 9	16018	17.80	87.1	3.7	2.4	1.9	0.3	0.0	13.0
-10	16714	17.13	85.8	2.0	3.0	1.7	1.3	0.0	12.0
-11	15981	16.80	86.9	1.3	2.4	1.4	1.7	2.4	14.0
-12	17027	17.20	85.7	3.7	2.6	3.3	0.0	2.6	13.3
-13	17259	17.30	86.7	3.3	0.0	2.3	1.3	0.0	14.3
-14	18229	17.73	86.2	6.0	12.4	3.1	0.3	2.4	14.0
-15	16788	17.37	86.0	4.7	2.8	3.6	0.7	10.5	12.7
-16	16345	17.20	86.1	3.7	0.0	3.2	1.5	11.4	12.3
-17	13931	16.80	85.3	3.7	0.0	3.4	1.5	6.1	13.0
-18	15066	18.30	86.5	8.0	0.0	4.8	2.7	0.0	14.3
-19	14046	15.07	87.0	4.0	8.9	1.3	2.2	0.0	14.0
-20	17229	18.07	88.7	3.0	0.0	1.4	2.2	2.8	11.7

EVALUATION OF S_1 PROGENY FROM SELF-FERTILE, MULTIGERM, RANDOM-MATED POPULATIONS, SALINAS, CA, 2001

(TESTS 1901 and 901)

(cont.)

Variety	Test 1901 (VY) Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	Test 901 (NB) % Bolting 9/25	Powdery Mildew Mean	Downey Mildew %	Root Rot %	Stand Count No.
0931-# = RZM 9931⊗ (cont.)									
0931 -21	16707	16.57	85.6	4.3	71.2	1.8	2.8	0.0	14.0
-22	15805	16.90	86.5	0.3	12.9	2.7	1.5	2.8	13.3
0941-# = RZM 9941⊗									
0941 - 1	15056	17.97	86.1	3.0	4.3	2.6	1.7	0.0	15.3
- 2	13196	16.80	86.3	1.3	46.7	3.2	3.2	2.2	15.0
- 3	16416	18.27	85.2	3.3	1.9	3.2	0.7	0.0	16.7
- 4	16832	17.30	88.0	4.3	11.2	2.2	1.5	0.0	15.0
- 5	14131	17.63	86.5	3.0	14.7	3.7	2.7	0.0	11.0
- 6	14701	17.73	85.3	1.7	0.0	1.1	0.0	3.0	11.7
- 7	15410	18.30	88.3	4.0	43.8	3.2	0.7	4.8	12.7
- 8	16937	16.77	87.0	0.7	0.0	1.3	0.8	2.8	12.3
- 9	16703	17.50	85.5	1.3	12.2	2.8	2.5	0.0	12.3
-10	15042	16.73	84.9	2.3	0.0	1.3	1.7	0.0	15.0
-11	17090	17.90	89.2	1.3	27.1	2.4	2.0	2.6	13.7
-12	14969	17.53	86.5	0.7	5.6	2.1	3.2	6.7	14.0
-13	15617	16.50	84.5	0.7	2.4	2.4	1.2	2.6	14.0
-14	16468	16.60	85.4	0.7	71.2	2.6	0.7	0.0	10.3
-15	14401	16.67	84.4	2.3	0.0	2.1	1.2	3.0	12.7
-16	18153	17.80	86.1	4.0	12.7	3.8	0.0	2.8	12.7
-17	12009	17.23	83.4	0.3	16.4	3.0	0.2	0.0	11.3
-18	16045	16.13	87.1	0.0	0.0	1.0	0.2	3.3	10.0
-19	13982	17.17	86.5	2.0	0.0	2.8	0.2	0.0	15.0
-20	16491	18.60	87.3	3.3	0.0	2.1	0.2	3.3	11.7

EVALUATION OF S_1 PROGENY FROM SELF-FERTILE, MULTIGERM, RANDOM-MATED POPULATIONS, SALINAS, CA, 2001

(TESTS 1901 and 901)
(cont.)

Variety	Test 1901 (VY) Sugar Yield Lbs	Test 1901 (VY) Sucrose %	Test 1901 (VY) RJAP %	Test 1901 (VY) Powdery Mildew Score	Test 901 (NB) % Bolting 9/25	Test 901 (NB) Powdery Mildew Mean	Test 901 (NB) Downey Mildew %	Test 901 (NB) Root Rot %	Test 901 (NB) Stand Count No.
0941-# = RZM 9941⊗ (cont.)									
0941 -21	14589	16.20	84.8	8.0	26.3	5.2	1.5	2.6	12.3
-22	15942	16.77	84.9	1.7	0.0	2.3	0.0	0.0	15.3
-23	15082	16.43	85.8	2.7	29.1	2.9	1.0	0.0	13.7
-24	14721	16.30	87.4	2.3	26.3	3.0	0.7	0.0	14.0
-25					100.0	0.0	0.3	0.0	1.0
-26	15944	16.97	85.8	3.0	25.3	3.1	0.2	2.8	10.7
-27	15015	17.00	87.2	1.3	0.0	1.7	1.2	0.0	11.0
0936-11	14333	16.97	85.1	2.7					
0934-# = RZM 9934⊗; = RZM 8934(C) = C76-89-5 x (C913-70 x R636)									
0934 - 1	15422	16.97	89.2	4.0	2.4	3.7	1.3	2.2	15.0
- 2	15125	17.43	89.1	7.7	17.7	4.1	0.7	0.0	15.3
- 3	15743	16.30	85.8	2.7	8.9	1.4	1.3	0.0	15.0
- 4	17922	16.83	87.0	5.0	0.0	2.6	0.8	0.0	15.7
- 5	12191	18.43	84.2	6.0	64.3	6.0	0.2	0.0	15.3
- 6	18212	17.47	86.3	7.0	5.1	2.6	0.7	0.0	14.7
- 7	17036	16.73	84.3	2.0	2.8	4.1	2.0	2.1	13.7
- 8					10.3	4.2	0.3	0.0	12.7
- 9					70.6	8.3	0.2	0.0	14.0
-10					93.0	5.4	0.2	0.0	12.3
-11					13.2	2.4	0.7	0.0	15.0
0934 - 8	17174	16.53	87.5	3.0					
0936 - 8	14289	18.77	87.3	1.0					
0941	17892	17.83	88.5	5.0					
0931	18488	17.90	88.9	4.0					

EVALUATION OF S_1 PROGENY FROM POPULATION-933, SALINAS, 2001

(TESTS 2001, 1001, 6001)

	Test 2001 (VY)				Test 1001 (NB)				Test 6001 (RZM)			
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	Powdery Mildew	Downey Mildew	Root Rot	Sugar Yield	Sucrose	RJAP	Appear Score
	Lbs	%	%	Score	9/25	Mean	%	%	Lbs	%	%	Mean
Checks												
9933	20466	18.57	90.1	5.0	20.5	4.4	2.0	4.2	9372	17.10	86.2	2.0
0931	19719	17.60	87.6	4.7	18.7	4.0	1.8	0.0	10094	17.90	86.5	1.7
CR011	18790	17.17	86.8	5.0	74.8	4.2	0.7	0.0	10808	17.07	86.5	1.7
00-SP22-0	14572	17.40	88.3	5.3	90.2	4.1	1.5	2.0				
US H11									6462	16.30	85.5	3.3
0933-# = RZM 9933⊗; = 8933aa x A = S_1 (mmaa x RAR)												
0933 - 1	15550	16.43	84.3	7.7	32.8	5.0	1.2	0.0	7589	16.80	83.3	3.0
- 2	15587	16.50	83.5	5.7	2.6	2.9	3.0	0.0	8582	16.70	82.3	3.0
- 3	16017	17.70	87.6	7.0	32.1	4.2	1.7	0.0	8390	17.70	86.5	2.3
- 4	16155	17.17	86.9	3.0	7.3	1.4	1.2	0.0	9152	17.03	86.2	1.3
- 5	14945	15.67	86.0	1.7	47.9	2.3	1.8	0.0	7572	16.00	87.0	2.7
- 6	14274	16.60	85.5	8.0	0.0	5.0	1.2	0.0	9326	16.63	82.8	2.7
- 7	17764	17.97	90.3	4.0	2.2	2.2	0.7	0.0	6937	17.23	87.9	2.3
- 8	16706	17.47	86.2	2.7	14.5	3.7	1.3	0.0	8287	17.50	85.8	3.0
- 9	13143	17.20	83.4	2.0	4.6	3.0	0.2	0.0	5447	17.23	83.6	3.7
-10	18133	17.00	88.2	6.3	7.0	2.9	0.7	0.0	8608	16.73	86.4	2.7
-11	15997	16.37	88.3	7.7	5.6	4.2	1.5	0.0	7315	16.87	83.5	2.0
-12	16127	17.47	86.6	6.0	2.1	4.9	2.7	0.0	7674	16.97	83.7	2.3
-13	13233	16.33	85.2	2.7	0.0	4.4	2.5	0.0	11556	16.80	86.0	2.7
-14	16732	18.10	86.6	0.0	21.7	1.4	0.5	0.0	9128	17.43	87.2	1.7
-15	16939	16.27	86.5	5.0	0.0	3.8	1.7	0.0	7868	16.43	86.9	2.7
-16	17909	16.83	87.7	1.0	22.2	2.4	4.7	2.2	7657	16.23	86.7	2.0
-17	20345	18.13	87.4	2.7	14.9	3.1	1.7	0.0	7830	18.23	87.5	2.7
-18	15541	17.43	87.5	5.3	0.0	3.8	2.8	0.0	7932	17.33	84.3	2.7
-19	17702	16.63	88.9	5.7	2.6	4.2	2.0	0.0	7492	17.20	85.3	3.0
-20	16702	17.67	86.0	5.3	37.3	3.2	1.5	0.0	8188	17.03	86.0	2.7

EVALUATION OF S_1 PROGENY FROM POPULATION-933, SALINAS, 2001

(TESTS 2001, 1001, 6001)

(cont.)

	Test 2001 (VY)				Test 1001 (NB)				Test 6001 (RZM)			
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	Powdery Mildew	Downey Mildew	Root Rot	Sugar Yield	Sucrose	RJAP	Appear Score
	Lbs	%	%	Score	9/25	Mean	%	%	Lbs	%	%	Mean
0933-# = RZM 9933⊗; = 8933aa x A = S_1 (mmaa x RAR) (cont.)												
0933-21	16543	17.10	85.7	7.7	2.4	5.3	0.7	0.0	8328	17.30	86.5	2.3
-22	15105	16.57	88.0	2.3	2.1	1.9	1.5	0.0	7937	16.73	87.5	2.3
-23	16852	16.50	85.0	5.7	4.3	3.8	1.3	0.0	7856	16.73	85.1	2.3
-24	18551	16.93	87.8	5.0	9.0	3.9	1.8	0.0	9532	16.80	88.1	2.3
-25	13214	16.57	86.6	6.0	7.1	5.1	1.8	0.0	7671	17.27	82.4	3.3
-26	17425	17.57	86.4	6.0	19.3	5.0	1.8	4.8	7319	17.83	84.8	3.0
-27	17349	17.93	86.4	7.7	12.3	6.4	0.8	2.4	7614	17.37	83.4	3.3
-28	15565	17.53	84.0	3.3	0.0	3.9	2.2	0.0	8130	17.23	83.4	3.0
-29	16314	16.87	84.6	6.3	0.0	5.6	1.3	0.0	8267	16.13	83.4	3.0
-30	17134	16.27	86.2	3.7	24.4	3.6	2.2	0.0	6402	17.10	85.9	3.0
-31	17325	18.10	87.7	8.3	0.0	4.3	0.2	0.0	8868	17.10	83.4	2.7
-32	17691	17.87	85.7	5.3	0.0	5.7	0.3	0.0	7285	16.80	85.1	2.0
-33	14079	17.07	85.9	3.0	24.2	3.6	0.8	0.0	7360	16.83	85.4	2.3
-34	14193	15.83	86.2	3.0	23.1	4.9	1.5	0.0	5246	16.77	80.9	3.0
-35	15539	18.13	87.9	3.3	13.1	2.3	0.5	0.0	6383	17.93	87.1	3.3
-36	14119	15.73	87.4	3.7	5.6	3.4	1.5	0.0	7805	17.13	84.3	3.3
-37	16363	16.30	84.3	4.3	0.0	2.9	2.2	0.0	7179	16.43	85.1	3.3
-38	16836	17.90	85.9	5.0	50.0	4.0	1.3	0.0	7265	17.60	88.3	2.3
-39	14460	16.60	93.6	3.0	6.1	3.9	0.7	0.0	6769	16.63	85.5	3.3
-40	15784	16.03	85.6	3.3	35.0	2.9	1.5	0.0	8049	17.23	84.3	3.0
-41	16368	16.23	84.4	0.7	9.1	2.4	0.7	0.0	7428	16.47	86.6	2.3
-42	19759	17.67	86.9	3.0	10.0	2.1	0.7	0.0	8516	17.53	88.3	3.0
-43	15978	17.63	85.8	2.7	0.0	1.8	0.3	0.0	8578	17.07	83.7	2.7
-44	15348	17.40	85.6	6.0	4.8	4.1	0.5	0.0	8266	17.13	84.6	3.3

TEST 1101. EVALUATION OF MONOGERM S_1 PROGENY FROM OTHER O-TYPE INDEXING FOR NONBOLTING, SALINAS, 2000-2001

32 entries x 3 reps, sequential
1-row plots, 11 ft. long

Planted: November 12, 2000
Not harvested for yield

Variety	Description	Stand Count No.	% Bolting 6/19	% Bolting 7/26	% Bolting 8/29	% Bolting 9/25	Powdery Mildew Mean	Seedling Vigor Score	Downey Mildew Mean	Root Rot %
Checks										
0833-5(Sp)	9833-5(T-O)mmaa x A	14.7	4.6	4.6	11.6	11.6	3.6	2.0	1.0	2.4
0911-4-10m(Sp)	9911-4-10(C)mmaa x A	15.3	0.0	0.0	0.0	0.0	3.3	3.3	1.2	0.0
FC123-# = 99-FC123mm⊗										
00-FC123- 5gh	99-FC123mm⊗	13.0	0.0	0.0	0.0	0.0	3.2	3.0	0.2	0.0
- 7		12.7	0.0	0.0	2.4	2.4	5.0	3.0	3.3	4.8
- 8		14.3	0.0	0.0	0.0	0.0	4.3	2.3	0.8	0.0
- 9		11.7	0.0	0.0	0.0	4.2	3.7	3.3	1.3	0.0
-12		13.3	0.0	0.0	0.0	0.0	3.7	3.0	1.7	0.0
-17		10.0	0.0	0.0	0.0	0.0	2.6	3.7	1.7	4.2
0869-# = 9869mm⊗										
0869 - 1	9869mm⊗	11.0	3.0	8.8	12.2	12.2	3.9	3.0	1.2	0.0
- 2		14.7	0.0	11.9	21.4	21.4	4.1	2.0	0.5	2.1
- 3		12.7	0.0	7.7	13.2	15.8	4.9	2.7	1.0	0.0
- 4		16.3	0.0	0.0	2.1	6.3	6.0	2.0	0.8	0.0
- 7		9.3	3.7	6.7	10.9	10.9	4.2	4.0	1.5	0.0
- 9		14.0	7.2	16.5	28.4	28.4	3.9	2.0	0.0	0.0
-11		15.7	0.0	15.6	31.8	36.2	7.0	2.7	2.3	0.0
-12		13.0	0.0	2.6	2.6	2.6	2.1	3.0	0.8	0.0
-13		14.3	4.3	29.6	50.5	55.3	4.4	2.7	0.3	2.8
-15		11.7	0.0	0.0	0.0	0.0	2.0	3.3	1.5	0.0
-18		11.3	14.1	19.7	23.0	26.0	6.3	2.7	1.0	0.0
-20		15.0	0.0	0.0	2.1	2.1	5.7	2.0	0.5	0.0

TEST 1101. EVALUATION OF MONOGERM S_1 PROGENY FROM OTHER O-TYPE INDEXING FOR NONBOLTING, SALINAS, 2000-2001

(cont.)

Variety	Description	Stand Count	% Bolting				Powdery Mildew	Seedling Vigor	Downey Mildew	Root Rot
		No.	6/19	7/26	8/29	9/25	Mean	Score	Mean	%
0869-# = 9869mm⊗ (cont.)										
0869 -21	9869mm⊗	13.7	0.0	0.0	4.6	11.3	6.6	2.0	0.3	0.0
-22		14.3	2.1	2.1	4.2	4.2	4.4	2.0	0.2	0.0
-30		11.3	0.0	0.0	0.0	2.6	1.3	2.7	0.5	0.0
-33		12.7	0.0	2.6	10.3	10.3	2.1	2.3	0.7	0.0
0840-# = RZM 9840mm⊗										
0840 - 2	RZM 9840mm⊗	17.0	0.0	0.0	0.0	0.0	7.0	1.0	0.2	0.0
- 3		16.0	0.0	0.0	0.0	2.1	4.4	2.0	0.2	0.0
- 4		16.0	8.0	23.1	27.4	29.4	4.6	2.0	0.0	2.2
- 5		14.3	0.0	0.0	0.0	2.8	1.8	2.0	0.7	0.0
- 8		11.0	0.0	0.0	0.0	18.5	3.9	3.0	0.2	0.0
- 9		15.7	0.0	0.0	0.0	0.0	2.6	2.0	0.7	0.0
-10		12.7	0.0	3.0	8.2	8.2	3.8	2.0	0.3	2.4
-11		15.7	2.2	6.5	10.8	13.1	2.2	2.3	0.2	0.0
Mean		13.6	1.5	5.0	8.7	10.5	4.0	2.5	0.8	0.7
LSD (.05)		2.5	4.7	9.0	11.1	15.1	1.4	0.7	1.2	4.1
C.V. (%)		11.1	186.0	109.9	78.6	87.9	20.7	16.4	86.6	386.2
F value		5.1**	3.7**	6.1**	9.6**	5.8**	10.0**	7.1**	3.1**	0.9NS

TOPCROSS HYBRID SCREENING TRIAL OF MONOGERM S_1 PROGENY LINES, 2001

(TESTS 3501, 1201, 7501, B701)

	Test 3501 (VY)			Test 1201 (NB)				Test 7501 (RZM)			Test B701(RZM)		
Variety	Sugar Yield	Sucrose	RJAP	% Bolting	Powdery Mildew	Downey Mildew	Root Rot	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose	Appear Score
	Lbs	%	%	9/25	Mean	Mean	%	Lbs	%	%	Lbs	%	Mean
Checks													
Beta 4430R	18141	17.40	88.7	19.0	2.4	0.5	0.0	7323	18.23	87.1	5274	15.99	2.9
HH142	15887	17.30	87.9	54.0	3.1	0.2	0.0	7203	17.58	86.3	5894	15.64	3.1
Phoenix	17083	17.22	89.7	23.8	2.2	0.7	0.0	6400	17.83	89.4	4457	14.25	3.6
Beta 4776R	15757	16.98	88.3	42.6	1.9	1.8	17.6	7516	17.55	86.9	6390	14.98	3.0
R078H50	16600	17.30	87.9	28.9	3.0	0.8	9.3	7639	17.63	87.9	4381	15.62	3.4
R078H5	15262	17.27	86.5	17.5	3.4	2.0	15.6	7347	17.88	85.4	6422	16.20	2.9
Y075H50	15274	16.67	86.5					7925	17.15	84.3	7074	15.80	1.9
R078H27	14588	16.13	83.4					7538	17.58	83.4			
Y071H50											7335	15.57	2.5
R078(Sp)				21.8	2.8	2.3	0.0						
97-US22/3				91.9	3.2	0.5	0.0						
R078H3				32.1	4.0	0.8	6.3						
S_1 progenies from popn-848													
R078H18	14147	17.10	86.4	20.6	4.0	1.2	2.0	8269	17.55	87.6	4002	15.96	3.4
R078H48 - 1	14781	16.70	86.2	17.0	4.3	1.2	6.3	7621	17.73	85.6	7581	16.59	2.4
- 2	15425	16.70	85.8	13.1	3.7	1.3	7.8	6580	17.75	87.6	6473	15.57	2.5
- 3	15544	16.73	86.2	24.7	4.1	2.2	11.1	5090	17.23	84.9	5923	14.61	2.6
- 4	14177	16.45	85.1	38.1	4.2	3.5	1.8	7751	17.35	86.2	5461	15.25	3.0
- 6	13586	16.30	85.7	20.7	4.8	1.2	0.0	6503	16.90	87.8	5420	14.37	2.5
- 7	14711	16.48	85.9	25.0	4.8	0.7	0.0	7806	16.88	86.0	7069	15.45	2.1
- 8	14400	16.85	87.0	20.6	4.7	0.5	1.8	6206	17.52	85.7	3577	15.37	3.8
- 9	15009	16.63	86.4	16.8	3.9	1.7	10.4	7991	17.00	87.0	5925	15.57	2.1
-10	13659	16.45	87.4	19.2	4.6	1.5	0.0	6747	17.00	89.0	4974	15.07	2.5
-11	15602	16.50	86.4	26.4	5.6	1.8	2.0	6655	17.15	86.1	5102	15.82	3.1
-12	15366	16.98	87.6	25.7	4.3	2.3	2.1	6869	17.33	85.7	5823	16.32	3.0

TOPCROSS HYBRID SCREENING TRIAL OF MONOGERM S_1 PROGENY LINES, 2001

(TESTS 3501, 1201, 7501, B701)

(cont.)

	Test 3501 (VY)			Test 1201 (NB)				Test 7501 (RZM)			Test B701(RZM)		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	% Bolting 9/25	Powdery Mildew Mean	Downey Mildew Mean	Root Rot %	Sugar Yield Lbs	Sucrose %	RJAP %	Sugar Yield Lbs	Sucrose %	Appear Score Mean
S_1 progenies from popn-810													
R078H10 - 1	14011	16.40	85.0	12.4	4.0	2.0	16.4	6941	16.57	85.9	5560	15.02	2.9
- 2	14943	16.70	86.1	32.3	3.4	2.2	19.0	7086	16.60	85.2	4614	15.69	3.4
- 3	13665	16.45	83.5	22.9	2.3	1.8	4.2	7928	17.33	85.7	4527	16.09	3.3
- 4	14283	17.00	86.2	14.5	3.8	1.5	2.1	7769	17.40	85.3	4062	16.02	3.3
- 5	13722	16.73	86.6	49.7	3.8	1.0	2.6	6057	17.35	88.2	3380	15.36	3.5
- 6	13707	16.52	86.7	21.3	5.2	1.2	7.8	8050	17.08	86.1	6763	14.94	2.6
- 8	14128	16.85	86.1	21.4	4.7	1.0	4.4	5851	17.95	85.9	4768	15.38	3.3
- 9	12549	16.58	83.9	16.2	4.2	2.5	23.9	6363	17.50	84.0	4549	15.86	3.0
-10	11196	15.88	85.2	36.8	4.0	0.7	10.0	5645	16.63	86.5	4127	14.94	3.0
-11	13869	15.88	86.0	25.2	3.9	1.7	11.1	7681	17.02	87.2	4546	15.38	3.8
-12	13917	15.95	87.0	14.7	3.3	2.8	0.0	6498	17.20	84.7	4729	14.39	3.5
R078H19	14615	16.55	85.8					6987	18.17	86.5	5692	15.40	2.4
R078H10 -14	14441	16.33	85.2	24.5	2.7	1.0	4.2	9110	17.15	86.6	2566	15.51	3.8
-15	13877	16.63	86.6	12.3	4.4	0.5	2.1	7118	17.70	86.9	6015	15.41	2.8
-16	13701	16.55	84.7	13.9	2.8	1.3	9.4	8558	17.40	85.2	3433	16.43	3.6
-17	14016	16.30	85.9	8.3	3.0	1.7	10.4	6896	17.25	84.2	7474	16.44	2.3
-18	14403	16.80	86.3	11.3	2.8	2.3	16.7	8376	17.75	85.2	2249	16.37	4.3
-19	14723	17.25	86.2	28.6	3.3	1.5	0.0	7335	16.85	86.9	8482	16.18	2.1
-20	13905	16.13	84.7	33.3	2.6	2.2	6.3	7480	17.08	87.1	6310	16.14	2.5
S_1 progenies from popn-815													
R078H15 - 2	14426	17.55	86.1	23.5	3.4	2.2	10.1	5536	17.60	86.2	4261	15.90	2.8
- 3	14508	17.35	87.8	30.4	2.7	1.7	18.6	6842	18.17	86.3	2976	16.76	3.4
- 4	14961	16.40	87.5	7.0	3.3	0.5	2.4				4660	14.95	3.4

TOPCROSS HYBRID SCREENING TRIAL OF MONOGERM S_1 PROGENY LINES, 2001

(TESTS 3501, 1201, 7501, B701)

(cont.)

Variety	Test 3501 (VY) Sugar Yield	Test 3501 (VY) Sucrose	Test 3501 (VY) RJAP	Test 1201 (NB) % Bolting	Test 1201 (NB) Powdery Mildew	Test 1201 (NB) Downey Mildew	Test 1201 (NB) Root Rot	Test 7501 (RZM) Sugar Yield	Test 7501 (RZM) Sucrose	Test 7501 (RZM) RJAP	Test B701(RZM) Sugar Yield	Test B701(RZM) Sucrose	Test B701(RZM) Appear Score
	Lbs	%	%	9/25	Mean	Mean	%	Lbs	%	%	Lbs	%	Mean
S_1 progenies from popn-815 (cont.)													
R078H15 - 5	14726	17.05	84.8	15.6	3.3	0.7	10.3	7383	17.00	86.0	5152	15.38	3.0
- 7	13405	17.27	86.4	23.8	3.2	2.0	0.0	7867	18.65	88.3	4906	15.56	2.9
- 8	13214	16.85	87.4	44.6	3.7	0.8	0.0	7750	17.67	88.1	3131	15.59	4.0
- 9	15488	16.63	85.4	34.0	3.9	0.5	1.9	9318	17.23	87.5	5045	14.91	3.1
-10	14949	16.98	86.8	35.8	2.6	0.3	6.1	8010	17.67	87.5	4190	15.32	3.4
-11	15268	16.35	88.5	56.4	3.1	0.3	2.4	8012	17.52	88.1	5375	14.85	3.1
S_1 progenies from popn-869													
R078H70	14726	16.58	87.1	26.8	4.3	0.8	6.7	7734	17.60	87.3	3312	15.69	3.8
R078H69 - 2	13652	16.08	85.2	25.8	3.0	1.2	2.2	7301	16.60	85.4	5834	16.14	2.6
- 4	13682	16.23	85.4	21.1	3.2	0.7	0.0	4934	17.13	86.4	3908	14.04	2.9
- 6	12802	16.38	85.7	40.8	4.1	0.0	0.0	6006	16.80	84.3	3711	15.90	3.6
- 7	16393	16.63	87.4	22.5	3.7	0.3	2.1	7902	17.00	85.2	4127	15.66	3.4
- 9	14327	17.40	87.1	21.7	4.1	0.8	4.2	6052	17.42	88.4	4816	15.39	3.4
-10	13699	16.65	86.3	30.6	3.9	1.0	0.0	6289	17.05	85.0	2644	14.76	3.4
-11	12622	16.92	87.0	15.6	4.4	0.5	0.0	6249	17.55	86.4	3723	14.76	3.6
-12	14435	16.60	86.5	40.0	2.2	1.3	1.9	6736	17.45	84.9	3872	18.40	3.9
-13	15901	16.30	84.5	23.8	4.2	0.3	2.1	8004	16.95	86.6	3796	15.17	3.4
S_1 progenies from popn-835													
R078H35	15892	16.67	86.4	31.0	3.7	0.3	1.9	7535	17.73	86.7	5517	14.76	3.0
R078H55	14971	16.83	86.1	42.2	2.8	0.5	0.0	7080	17.63	85.8	5175	14.70	3.1

TOPCROSS HYBRID SCREENING TRIAL OF MONOGERM S_1 PROGENY LINES, 2001

(TESTS 3501, 1201, 7501, B701)

(cont.)

	Test 3501 (VY)			Test 1201 (NB)				Test 7501 (RZM)			Test B701(RZM)		
Variety	Sugar Yield	Sucrose	RJAP	% Bolting	Powdery Mildew	Downey Mildew	Root Rot	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose	Appear Score
	Lbs	%	%	9/25	Mean	Mean	%	Lbs	%	%	Lbs	%	Mean
S_1 progenies from popn-835 (cont.)													
R078H35 - 2	14627	16.80	87.8	19.7	4.0	1.3	2.1	8419	17.63	87.0	3691	15.20	3.4
- 3	14409	16.95	87.3	35.3	3.0	1.2	5.9	9204	17.55	89.8	5446	15.84	2.4
- 4	13578	16.17	82.6	22.9	3.1	0.8	7.8	7033	17.50	85.6	5434	15.57	3.0
- 5	14033	16.40	85.3	36.2	2.9	1.2	12.3	6598	17.80	87.6	4608	15.38	3.1
- 6	14633	16.63	85.5	26.5	2.0	0.3	0.0	7650	17.58	86.3	3637	15.19	3.6
- 7	13946	16.83	86.5	22.1	4.3	0.2	0.0	6951	16.95	85.0	4661	15.25	3.0
- 8	15024	17.00	86.0	19.7	4.4	0.3	0.0	6824	17.03	85.0	7197	16.28	2.9
- 9	12925	16.63	85.8	17.4	3.4	1.3	8.9	6995	17.27	84.8	3930	16.58	3.6
-10	15428	17.67	89.1	45.0	3.0	0.2	0.0	8522	18.27	86.8	3699	15.44	4.0
-11	15413	16.63	85.3	13.1	3.6	0.8	6.5	9065	17.05	87.1	6450	15.44	2.5
-12	14265	16.58	87.7	10.9	2.9	0.2	0.0	9052	18.23	88.4	4530	15.31	3.0
-13	14078	16.83	87.9	33.9	3.2	0.5	0.0	6060	17.33	86.4	3461	14.68	3.9
-14	13738	16.63	87.5	10.8	3.0	0.5	2.2	7898	16.88	86.0	2846	14.89	3.8
-15	14131	16.75	86.7	20.8	2.8	0.5	2.1	7932	17.65	88.4	4882	14.77	3.0
-16	15146	16.45	83.9	22.2	3.3	0.8	8.2	8152	17.88	85.4	5275	14.74	3.0
-17	14461	16.48	85.8	48.8	3.9	0.8	4.2	7464	17.58	84.6	5442	15.62	2.8
-18	14045	16.67	86.5	21.0	4.2	0.5	4.2	6375	17.40	86.2	4120	14.80	3.5
-19	14392	16.65	85.9	15.3	4.0	0.5	2.2	6994	17.20	87.1	3800	14.45	2.9
-20	14999	16.13	86.3	64.3	3.6	1.0	0.0	7749	17.88	85.3	6133	14.95	3.0
-21	13369	16.10	87.0	60.5	5.2	0.3	2.0	7419	17.67	88.1	3637	14.68	3.6
-22	13654	16.48	86.4	25.0	3.1	0.3	2.4	7852	17.27	85.9	3589	15.21	3.3
-23	14773	15.75	85.1	31.5	4.8	0.7	7.1	8440	16.63	88.0	5009	14.99	3.1
-24	13747	16.65	85.9	20.6	3.4	0.3	0.0	7967	17.13	86.3	8364	16.22	2.3

TOPCROSS HYBRID SCREENING TRIAL OF MONOGERM S_1 PROGENY LINES, 2001
(TESTS 3501, 1201, 7501, B701)

(cont.)

Variety	Test 3501 (VY) Sugar Yield Lbs	Test 3501 (VY) Sucrose %	Test 3501 (VY) RJAP %	Test 1201 (NB) % Bolting 9/25	Test 1201 (NB) Powdery Mildew Mean	Test 1201 (NB) Downey Mildew Mean	Test 1201 (NB) Root Rot %	Test 7501 (RZM) Sugar Yield Lbs	Test 7501 (RZM) Sucrose %	Test 7501 (RZM) RJAP %	Test B701(RZM) Sugar Yield Lbs	Test B701(RZM) Sucrose %	Test B701(RZM) Appear Score Mean
S_1 progenies from popn-835 (cont.)													
R078H35 -25	13718	16.55	88.5	45.7	3.1	0.7	0.0	5854	17.58	85.2	2796	15.32	4.0
-26	15822	16.92	87.0	38.1	3.1	0.2	0.0	8370	17.20	85.7	3628	14.51	3.4
-27	14140	17.23	86.1	61.5	3.8	0.2	2.1	8627	17.73	84.8	5138	16.41	3.0
S_1 progenies from popn-836													
R078H56	14253	16.55	86.2	32.7	3.7	0.0	0.0	7809	17.35	85.0	4531	14.69	2.9
R078H36 - 4	13972	17.30	87.1	46.7	2.4	0.2	0.0	8426	17.23	86.1	5473	15.50	3.5
- 6	13316	16.35	87.2	18.3	4.1	0.5	2.2	8021	17.67	85.9	3484	15.55	3.4
- 7	13221	15.90	86.6	6.4	4.2	0.0	0.0	9209	16.85	85.3	4444	15.08	2.6
R078H36 -10	14298	16.05	84.8	11.8	3.3	0.0	0.0	10423	17.40	85.1	4487	14.43	3.0
-11	13807	16.35	84.5	34.2	3.6	0.2	2.1	8329	17.70	85.7	4039	15.31	3.3
-12	14471	16.60	85.9	28.9	3.4	0.5	3.9	10339	17.35	87.6	4396	15.24	3.1
-13	15034	17.27	85.4	22.0	3.3	0.8	7.4	10691	17.50	85.7	4716	15.91	2.9
-14	15306	16.73	85.8	14.7	2.1	0.0	0.0	6907	17.40	85.5	3475	13.61	3.4
-16	15658	16.88	84.6	17.6	2.8	0.2	2.0	8945	17.67	84.8	2883	14.87	4.0

Project 281

Effects of *Beet necrotic yellow vein virus* (BNYVV), *Beet soil-borne mosaic virus* (BSBMV), and their fungal vector, *Polymyxa betae* on seedling emergence, plant growth and virus concentration in sugarbeet

G.C. Wisler, R.T. Lewellen, J.L. Sears, J.W. Wasson, H.-Y.Liu, and W.M. Wintermantel
USDA-ARS, Salinas, CA

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The Western Sugar Company-Grower Joint Research Committee

Introduction:

Rhizomania is widespread in the High Plains, as well as throughout most areas of the United States where sugarbeet is grown. This disease is caused by *Beet necrotic yellow vein virus* (BNYVV), a benyvirus transmitted by the soil-borne fungus *Polymyxa betae.* All BNYVV isolates from soils in the U.S. are identical, based on: (1) studies of the responses of susceptible host plants; (2) serological relatedness of the coat protein and several nonstructural proteins; (3) the number and size of the RNAs in each isolate; (4) and the relationship of each RNA on a molecular level compared to a European isolate of BNYVV. This American isolate was probably introduced from Europe, where multiple isolates exist, and has since spread throughout North America. *Beet soil-borne mosaic virus* (BSBMV) is often present in beet plants that are also infected with BNYVV. All BSBMV isolates are serologically identical to one another, but differ in host response and the number and size of viral RNAs. This pattern is indicative of a virus which originated and has evolved in North America. None of the BSBMV isolates cause the root proliferation characteristic of Rhizomania disease and BNYVV infection, but our studies indicate that BSBMV isolates do reduce growth of beets (Wisler et al., submitted).

Several control measures have been established for rhizomania. These have been developed over several years of research by pathologists and breeders, and include: (i) avoidance of infested fields by testing soil for the presence of *Beet necrotic yellow vein virus* (BNYVV) prior to planting, (ii) early planting into cool soils, (iii) soil fumigation where allowed, and (iv) use of resistant cultivars. These measures apply to all soil-borne fungus-transmitted viruses of sugarbeet, including BNYVV, *Beet soil-borne mosaic virus* (BSBMV), and *Beet soil borne virus* (BSBV). Viruliferous *P. betae* (*P. betae* containing virus) remains in soil after harvest and can survive for many years. It is important, therefore, to decrease levels of virus inoculum in the soil by whatever means possible. The most cost-effective and successful control measure for growing beets in infested soil is the use of resistant varieties. Many sugarbeet cultivars have now been bred with varying degrees of resistance to rhizomania. Resistant varieties are not immune to BNYVV, but do reduce virus accumulation and disease severity. Current resistant varieties now yield nearly as well as non-resistant varieties in the absence of rhizomania disease pressure.

Over the past several years, both sugar and tonnage were decreased in Great Plains beet growing regions, to the extent that growers and industry alike have questioned replanting beets the following season. Several causes have been attributed to this problem including *Cercospora* leafspot, *Rhizoctonia*, root aphids, root maggots, rhizomania (caused by BNYVV) and BSBMV, to name a few. Although rhizomania had been blamed for these low yields, repeated tests from labs at the University of Nebraska in Scottsbluff were negative for BNYVV. This test was conducted with a modified diagnostic kit (produced by Agdia Inc. using antiserum developed in Salinas) which is a specific and reliable test for BNYVV. No data has been found to support the claim that Rhizomania alone was responsible for the decline. One of the most significant findings from the initial studies on the yield decline experienced by Great Plains region sugarbeet producers was that 24 of 27 soils tested, showing the decline in sugarbeet production were infested with either BSBMV, BSBV, or both. Only 2 of the soil samples were positive for BNYVV, and one of these was a soil which had been submitted as a rhizomania positive control. Although the effects of Rhizomania were well known on sugarbeet, much less was known about the effects of BSBMV or BSBV on beets. It was suspected that these viruses, either alone or in combination, contributed to a yield loss in sugarbeet, and results from previous studies by our laboratory in Salinas suggested that BSBMV, in particular, may be important in the yield losses.

Based on this information, studies were conducted in our greenhouses in Salinas examining soils infested with BNYVV, BSBMV, both viruses, and virus free *P. betae*, as well as virus and vector-free soil. The results of these studies identified two problems that significantly reduced sugarbeet growth, compared with non-inoculated control plants. Beets grown in soil infested with both BSBMV and BNYVV were sometimes stunted much more severely than those grown in soil infested with either virus alone. In addition, *P. betae*, with or without virus had a significant effect on beet growth. Studies on virus concentration in infected plants demonstrated that BNYVV is more competitive in sugarbeet than BSBMV, suppressing BSBMV concentrations in infected tissue during mixed infection.

Materials and Methods:

Maintenance of soil cultures. The USDA-ARS in Salinas, California has performed serological tests by ELISA for BNYVV as a service to the sugar beet industry since rhizomania was first detected in Paso Robles, California in 1983. Since the finding of BSBMV in Texas (Duffus et al., 1987), similar tests have been performed for this virus. Methods for rhizomania soil testing have been described by Gerik et al (1987). Soil samples previously identified as being singly infested with BNYVV, BSBMV, or aviruliferous *P. betae* have been increased and stored at 4C for this study. BNYVV-infested soil was taken from the sugar beet fields used in rhizomania variety trials at the USDA-ARS in Salinas, California that have been infested since the late 1980's. Tests are routinely made for BSBMV, and it has ever been detected in these fields. BSBMV-infested soil was obtained from sugar beet fields in Nebraska and was submitted by Dr. Eric Kerr. *P. betae*-infested soil was obtained from river sand and was submitted by Dr. Gary Franc. For the purposes of increasing infested soil samples, roots from pot cultures were air dried, homogenized in mortars and pestles, and thoroughly mixed back into respective soil samples. Non-infested soil consisted of sand collected from the Salinas River that was autoclaved prior to use.

Soil samples were mixed in equal parts with autoclaved builders' sand to facilitate ease of root removal at harvest. Pots, saucers and greenhouse benches were washed in dilute (10%) bleach solution prior to use. Ten-ounce Styrofoam cups with holes punched in the bottom for drainage were placed in plastic saucers spaced on greenhouse benches to avoid contamination by splashing water between pots. A list of computer-generated random numbers was used to determine the placement of each pot on the greenhouse benches for a completely random design. All pots were drenched with a fungicide treatment consisting of Apron 25W (0.5 tsp/gal) and Terraclor 75W (0.25 tsp/gal) to eliminate root rotting and damping off due to *Pythium* spp. and *Rhizoctonia* spp. Approximately 100 sugar beet seeds were layered on top of each pot. Each pot was covered with sand at a depth of about 1 cm, and was watered with gentle misting. From that point on, water was added to the saucers directly. Varieties used in tests 1, 2, and 3 were Beta4330R (*Rzrz*; resistant) and KWS6770 (*rzrzrz*; susceptible).

Test 1 consisted of the following treatments: (1) non-infested soil, (2) BSBMV-infested soil, (3) BNYVV-infested soil and (4) BNYVV- and BSBMV-infested soil, mixed in equal parts. In this test, only the rhizomania-susceptible variety (KWS6770) was used. Samples were harvested weekly for 6 weeks starting 2 weeks post emergence of seedlings. Each treatment combination (soil X harvest date) consisted of 6 pots each for a total of 144 pots. Test 2 and 3 expanded on test 1, by adding aviruliferous *P. betae* as a treatment, and a rhizomania-resistant variety (Beta 4430R). In these two tests, each treatment combination (soil x variety x harvest date) consisted of 3 pots each, which were also sampled at weekly intervals for 6 weeks, for a total of 180 pots.

Serological Assays: Previous studies (Obermeier, 1998; Tuitert, 1994) showed a clear relationship between virus concentrations in BNYVV-infected plants and absorbance values obtained in ELISA. A triple antibody sandwich (TAS)-ELISA was developed in collaboration with Agdia, Inc. that was specific for BNYVV, that gave a wide range of absorbance values for BNYVV, and correlated with the levels of the *Rz* gene as described above (Wisler et al., 1999). Polyclonal antiserum used as the trapping antibody was made from the BNYVV CP clone that was expressed *in vitro* (clone kindly provided by K. Richards). The pETH plasmid expressing the CP gene was identified by western blot assays and was used to transform the appropriate host for expression, *E. coli* strain BL21DE3pLysS, according to Studier et al. (1990). Antiserum was prepared in rabbits by Berkeley Antibodies (Richmond, California). This antiserum was used to coat microtiter plates according to Agdia protocols. The double antibody sandwich (DAS)-ELISA test was used to test for BSBMV. Antiserum to BSBMV was provided by H.-Y. Liu. Purified IgG (1mg/ml) was used to coat microtiter plates at a 1/1000 dilution. Alkaline phosphatase-conjugated IgG was used at a 1/1000 dilution. Plant samples consisted of roots that were washed from each pot free of soil. Root tissue (0.5g) was taken from each sample and added to 2 ml of extraction buffer (phosphate-buffered saline, pH 7.2 with 0.5% Tween 20 and 0.4% dry milk powder). Root tissues were homogenized in sample extraction bags using a hand held roller press (Agdia, Inc.). Expressed sap was added as paired wells to plates at 150 μl per well. A list of computer-generated random numbers was used to determine the placement of the test samples per harvest date on microtiter plates. Each plate also contained paired wells with (i) sample buffer only (ii) a BNYVV-infected root, (iii) BSBMV-infected root, and (iv) healthy root tissues in sugar beet (*Beta vulgaris* L.), (v) a BNYVV-systemically infected *B. macrocarpa* (*B. vulgaris* spp. *maritima* var. *macrocarpa*) leaf tissue, (vi) a BSBMV- systemically infected *B. macrocarpa* leaf tissue and (vii) healthy *B. macrocarpa* leaf tissue. The BNYVV monoclonal

used as the detecting antibody and the goat-anti-mouse IgG-alkaline phosphatase conjugate were provided by Agdia and used according to instructions. Absorbance readings (A_{405nm}) were made at 15 min intervals up to 2 hr using a Bio-Tek EL312e microplate reader (Winooski, VT).

Data analysis: Data were obtained from each individual pot and were used for statistical analyses. At each harvest, the number of plants per pot were counted and reported as a percentage for seedling emergence, and all plants within a pot were combined, blotted dry, and weighed. After obtaining the fresh weight, the combined roots of each pot were tested for virus titer (ELISA values at A_{405nm}) for BNYVV and BSBMV. For all three tests, each treatment combination was grown in a completely randomized design. Analyses of variance (ANOVA) were run using MSTAT.

Results:

Studies on the effect of virus interactions during mixed infection on accumulation of BNYVV and BSBMV in sugarbeet were completed during the summer of 2001. Soils naturally infested with cultures of avirulent *Polymyxa betae* and *P. betae* infected with the two sugarbeet-infecting benyviruses, BNYVV and BSBMV, alone and in combination, were compared to non-infested soil with regard to their effects on seedling emergence, fresh plant weight, and virus content. Two sugar beet varieties were used; a diploid (*Rzrz*) carrying resistance to rhizomania (caused by BNYVV), and a triploid rhizomania-susceptible variety (*rzrzrz*).

Our studies clearly show that:
1. *The Rz gene that confers resistance to BNYVV does not confer resistance to BSBMV in greenhouse assays* (Tables 1, 2, 3). BNYVV concentrations (based on ELISA tests) in the rhizomania susceptible variety were significantly higher than in the resistant variety, but no differences in BSBMV concentration occurred between these varieties when tested as single infections across all six harvest dates (Table 2). A significant variety by soil treatment interaction also occurred for BNYVV but not for BSBMV (Table 3), demonstrating that varieties containing the Rz resistance gene protect beets against BNYVV, but not BSBMV. confirming that resistance to BNYVV does not protect beets against BSBMV.

2. *P. betae alone had a significant negative effect on growth of sugar beet in greenhouse pot cultures*, illustrated by the results of tests 2 and 3. Seedling emergence and plant weight were reduced, even in the absence of BNYVV and BSBMV (Table 1, Table 4). Levels of BNYVV and BSBMV were at background levels in plants harvested from the aviruliferous *P. betae*-infested soil and the non-infested soil treatments, as indicated by the ratio of 1.0 for the test sample divided by the healthy absorbance (Table 5). *P. betae* infection also caused a significant reduction in plant weight for both resistant and susceptible varieties (Table 6). The difference between varieties in plant emergence could not be directly attributed to the effects of *P. betae* or either virus, but appeared to be caused by different seed lot age, quality, and emergence potential.

3. BNYVV either out competes or suppresses BSBMV in mixed infections, even in rhizomania-resistant varieties in which BNYVV concentrations are extremely low. BSBMV concentrations were significantly higher in plants infected with BSBMV alone than in mixed infections with

both BSBMV and BNYVV. This effect was observed in both the rhizomania-resistant and susceptible varieties. In test 1, where only the rhizomania-susceptible variety was used, BSBMV titers were reduced from strongly positive as single infections (almost 15 times the healthy mean), to values only slightly higher than healthy values when in mixed infections with BNYVV (3.5 times the healthy mean). In contrast, BNYVV values were 7.9 and 10.2 times the healthy mean in single and mixed infections, respectively (Tables 1, 7). In tests 2 and 3 levels of BSBMV were significantly reduced when they occurred as mixed infections with BNYVV compared to single infections (Table 1), whether they infect rhizomania-susceptible or resistant varieties (Table 7). In contrast, BNYVV concentrations were high (8 to 14 times the healthy mean) in single and in mixed infections in the rhizomania-susceptible variety, but were low (ca. three times the healthy mean) in the rhizomania-resistant variety. Therefore, in the absence of BNYVV, BSBMV titers are high, regardless of the resistance genotype. In the presence of BNYVV, however, BSBMV concentrations are low in both varieties, with absorbance (A_{405nm}) readings similar to those of non-infested soils. This demonstrated that interactions between soil-borne viruses significantly affect virus accumulation in sugarbeet, which will ultimately influence the amount of virus inoculum returned to the soil. The data suggest that BSBMV is not as competitive in sugarbeet as BNYVV. Not only is BNYVV a much more aggressive virus in terms of damage to sugarbeet, but it is effectively more competitive in its accumulation in sugarbeet tissue than BSBMV.

4. There is a strong tendency for *P. betae*-infested soils to have reduced seedling emergence and fresh weight, despite the use of protective fungicides (Table 6). This was evident in both rhizomania-resistant and susceptible varieties. Little is known about the incidence and distribution of P. betae in the absence of BNYVV or BSBMV. If aviruliferous (virus free) *P. betae* is common in sugarbeet production, this may be one of the many factors that impact yield.

Table 1. Main effect treatment means for BNYVV and BSBMV concentration (A_{405nm}), emergence, and total plant fresh weight evaluated for one (Test 1) or two (Test 2,3) varieties over five soil treatments and six weekly harvest dates.

Treatments	Test 1				Test 2				Test 3			
	BNYVV	BSBMV	Emergence	Weight	BNYVV	BSBMV	Emergence	Weight	BNYVV	BSBMV	Emergence	Weight
Grand Mean	5.0	5.1	52.8	39.4	3.0	2.5	63.3	21.6	2.1	1.7	57.7	9.3
Cultivars (C)	na	na	na	na								
Susceptible (*rzrzrz*)	na	na	na	na	4.7a	2.8a	45.8a	20.0a	2.7a	1.6a	29.8a	6.4a
Resistant (*Rzrz*)	na	na	na	na	1.4b	2.3a	80.7b	23.2b	1.5b	1.7a	85.5b	12.1b
Soil Treatments(S)												
Non-infested	1.0c	1.0b	61.9a	58.9a	1.0b	1.0b	72.5a	39.8a	1.0c	1.0b	63.3a	17.0a
P. betae-infested	nt	nt	nt	nt	1.0b	1.0b	67.2b	27.6b	1.0c	1.0b	59.3ab	9.1b
BSBMV-infested	1.1c	14.9a	49.3b	35.8b	1.0b	8.2a	73.4a	20.5c	1.0c	3.8a	55.3bc	7.7c
BNYVV-infested	7.9b	1.1b	51.8b	32.6c	6.6a	1.1b	49.8c	9.7d	5.0a	1.1b	57.6abc	6.6d
Mixed infection	10.2a	3.5b	48.2b	30.2d	5.7a	1.3b	53.4c	10.4d	2.4b	1.4b	52.7c	5.9d
Harvest Dates(H)												
Week1	3.6c	9.2a	52.4ab	21.4f	2.4bc	1.3c	58.9b	15.3d	1.6b	1.0a	54.5a	7.0e
Week 2	8.3a	2.9a	51.7ab	33.4e	3.3b	2.7bc	59.6b	19.4c	2.1ab	1.8a	56.6a	8.5d
Week 3	6.4b	3.8a	50.0b	39.1d	2.4bc	1.9bc	61.8ab	20.8c	1.5b	2.1a	60.0a	9.1cd
Week 4	6.7ab	6.8a	52.9ab	41.8c	1.9c	3.1b	67.1a	23.6b	1.4b	1.2a	56.4a	9.6bc
Week 5	2.8c	3.5a	55.7a	48.1b	5.0a	4.8a	66.3a	25.3a	3.0a	2.1a	61.4a	11.2a
Week 6	2.4c	4.5a	54.0ab	52.6a	3.3b	1.4c	65.9a	25.4a	3.0a	1.9a	57.0a	10.3ab

Means within columns followed by a different letter are significant at $P \leq 0.05$.

Table 2. Virus concentration means for rhizomania-resistant and -susceptible varieties grown in BNYVV- and BSBMV-infested soils.

	Test 2		Test 3	
Treatments	BNYVV[a]	BSBMV	BNYVV	BSBMV
Susceptible variety	4.7a[b]	2.8a	2.7a	1.6a
Resistant variety	1.4b	2.3a	1.5b	1.7a

[a]Values represent the ratio of the absorbance (A_{405nm}) reading for BNYVV or BSBMV, respectively, over the corresponding healthy absorbance value.

[b]Means within columns followed by a different letter are significant at P≤0.05.

Note: Means are across 6 dates of harvest and 5 soil treatments.

Table 3. Interaction means for BNYVV and BSBMV concentration between resistant and susceptible sugarbeet varieties grown in *P. betae*-infested soils containing either BNYVV or BSBMV.

	Test 2		Test 3	
Treatment Interactions	BNYVV[a]	BSBMV	BNYVV	BSBMV
Susceptible X BSBMV soil	1.0b[b]	9.2a	1.0c	3.7a
Susceptible X BNYVV soil	11.2a	1.1c	7.5a	1.0b
Resistant X BSBMV soil	1.0b	7.1b	1.0c	4.0a
Resistant X BNYVV soil	1.9b	1.1c	2.5b	1.2b

[a]Values represent the ratio of the absorbance (A_{405nm}) reading for BNYVV or BSBMV, respectively, over the corresponding healthy absorbance value.

[b]Means within columns followed by a different letter are significant at P≤0.05

Note: Means are across 6 dates of harvest.

Table 4. Mean seedling emergence and plant weight in greenhouse pot culture soil infested with virus-free *P. betae* and in non-infested soil.

	Test 2[a]		Test 3	
Soil Treatments	Emergence[b]	Plant Wt.(g)	Emergence	Plant Wt.(g)
Non-infested	73a[c]	40a	63a	17a
P. betae-infested	67b	28b	59a	9b

[a]Means are across varieties and harvest dates.

[b]Emergence is defined as total number of seedlings per pot.

[c]Means within columns followed by a different letter are significant at P≤0.05.

Table 5. BNYVV and BSBMV concentration in beets grown in soil infested with virus-free *P. betae* and non-infested soil.

Soil Treatments	Test 2[a] BNYVV[b]	BSBMV[b]	Test 3 BNYVV	BSBMV
Non-infested	1.0a[c]	1.0a	1.0a	1.0a
P. betae-infested	1.0a	1.0a	1.0a	1.0a

[a]Means are across varieties and harvest dates.
[b]Values represent the ratio of the absorbance (A_{405nm}) reading for BNYVV or BSBMV, respectively, over the corresponding healthy absorbance value.
[c]Means within columns followed by a different letter are significant at $P \leq 0.05$.

Table 6. Effects of virus-free *P. betae*-infested soil on mean seedling emergence and plant weight in rhizomania-susceptible and resistant sugarbeet varieties.

Treatments	Test 2[a] Emergence[b]	Plant Wt(g)	Test 3 Emergence	Plant Wt(g)
Susceptible X non-infested soil	55b[c]	38b	35b	14b
Susceptible X *P. betae*-soil	48b	27d	28b	6c
Resistant X non-infested soil	90a	42a	92a	20a
Resistant X *P. betae*-soil	86a	29c	91a	12b

[a]Means are across harvest dates.
[b]Emergence is defined as total number of seedlings per pot.
[c]Means within columns followed by a different letter are significant at $P \leq 0.05$.

Discussion

This study has demonstrated several important points regarding the effects of (1) *P. betae*, the vector of BNYVV and BSBMV, (2) BSBMV, and (3) mixed infections of BNYVV and BSBMV on the growth of sugar beet in greenhouse pot culture. In addition, our results have clearly shown that the *Rz* allele for resistance to rhizomania does not confer resistance to BSBMV. The three tests reported here were conducted at different times throughout the year, allowing for variation in temperature and day lengths, and the same significant effects were observed.

The effects of BNYVV, the cause of rhizomania, has been clearly demonstrated over many years of research. Symptoms include general yellowing, wilting, and occasionally the necrotic yellow vein symptom is expressed. In addition, rhizomania infection results in an economically limiting reduction in sugar and yield. In contrast, although BSBMV has been observed in beets for over 25 years in the United States, the effects of this virus on beet production was largely unknown. The relationship between these two viruses is important because if BSBMV has a deleterious

Table 7. Levels of BNYVV and BSBMV at A_{405nm} in ELISA tests in single and mixed infections in rhizomania-resistant and susceptible sugar beet varieties.

	Test 1				Test 2				Test 3			
	Resistant		Susceptible		Resistant		Susceptible		Resistant		Susceptible	
Soil Treatment	BNYVV[a]	BSBMV[a]	BNYVV	BSBMV	BNYVV	BSBMV	BNYVV	BSBMV	BNYVV	BSBMV	BNYVV	BSBMV
Non-infested	nt	nt	1.0c[b]	1.0b	1.0a	1.0b	1.0c	1.0b	1.0c	1.0a	1.0c	1.0b
P. betae	nt	nt	nt	nt	1.0a	1.0b	1.0c	1.0b	1.1c	1.1a	1.0c	1.0b
BSBMV	nt	nt	1.1c	14.9a	1.0a	7.1a	1.0c	9.2a	1.0c	4.0a	1.0c	3.7a
BNYVV	nt	nt	7.9b	1.1b	1.9a	1.1b	11.2a	1.1b	2.5ab	1.2a	7.5a	1.0b
Mixed infection	nt	nt	10.2a	3.5b	2.4a	1.2b	9.0b	1.5b	1.7bc	1.3a	3.1b	1.4b

[a]Values represent the ratio of the absorbance (A_{405nm}) reading for BNYVV or BSBMV, respectively, over the corresponding healthy absorbance value.
[b]Means within columns followed by a different letter are significant at $P \leq 0.05$.

effects on beet production, and if it is closely related enough for the *Rz* allele to confer resistance to it, the effects of this virus on beet will be reduced. Several years after BSBMV was discovered and before the Benyvirus genus was established in the family Furoviridae, it was suggested that rhizomania resistance would be effective against BSBMV because of its similarities to BNYVV, including particle morphology, particle size distribution, genome organization and distant serological relationships. We now know, however, that BSBMV is clearly a distinct virus from BNYVV (Lee et al., 2001) and our studies show that the *Rz* allele does not provide any resistance to BSBMV (Wisler et al. 1999, 2002).

Preliminary greenhouse studies (unpublished) using serial dilutions of *P. betae*-infested soil suggested that this fungus had a negative effect on growth of sugar beet. Our studies show a significant reduction in seedling weight and emergence when infected with *P. betae*, in comparison to non-infested soil. This was true for both rhizomania-susceptible and resistant varieties. Little is known about the incidence and distribution of *P. betae* in the absence of BNYVV or BSBMV. If aviruliferous *P. betae* is common in sugar beet production, this may be one of the many factors that impact the beet industry.

Our studies show that BSBMV alone replicates to high levels in both resistant and susceptible rhizomania varieties. However, when these viruses exist as mixed infections with BNYVV, the levels of BSBMV are significantly reduced, even when BNYVV levels are extremely low, as seen in the rhizomania resistant variety. This is not what we expected. During the first experiment (Test 1), conducted only with a susceptible (rzrz) sugarbeet variety, BSBMV levels were significantly reduced in mixed infections with BNYVV. As a result, we hypothesized that when these two viruses occur together in a rhizomania-resistant variety, that the BSBMV levels would greatly increase as the BNYVV levels decreased. Instead, BSBMV levels were significantly reduced in the rhizomania resistant variety as well, even with the extremely low levels of BNYVV present in these plants. The levels of BNYVV were also reduced in tests 2 and 3 in the susceptible variety, when in combination with BSBMV, but the levels of BNYVV observed are still considered strongly positive. In test 1, BNYVV levels were higher in the single than in the mixed infection. It is possible that interference or competition occurs between BNYVV and BSBMV when they exist as mixed infections. The significant reduction of BSBMV when in combination with BNYVV could be due to several factors, alone or in combination. One can speculate that it might involve the competitive sites for infection by viruliferous *P. betae*. Perhaps BNVYY-infected *P. betae* zoospores are more aggressive than BSBMV-infected *P. betae*. Alternatively, the viruses themselves could have a competitive advantage once inside the host cells, such that the initial virus to infect a cell (usually BNYVV) could prevent successful infection by the related virus. In fact, BSBMV accumulates more slowly in infected sugarbeet than BNYVV. BNYVV accumulates rapidly, and its concentration peaks early then slowly declines. BSBMV concentrations continue to accumulate gradually in infected beets (Wisler et al., 2000). If BNYVV is truly more aggressive and competitive than BSBMV, could partially explain the fact that BSBMV had not become established in all sugarbeet production regions whereas BNYVV is wide spread and occurs in high incidences in most U.S. production areas.

SUGAR BEET RESEARCH

2001 REPORT

Section B

U.S. Department of Agriculture, Agricultural Research Service
Northern Plains Area, (USDA-ARS-NPA)
Corps Research Laboratory, Sugar Beet Research Unit
1701 Centre Ave.; Fort Collins, CO 80526-2083

Phone: (907) 498-4204
Fax: (970) 482-2909
Email: lpanella@lamar.colostate.edu
Web access: http://www.crl.ars.usda.gov/

Dr. Lee Panella, Geneticist & Research Leader
Dr. Susan S. Martin, Plant Physiologist
Dr. Linda E. Hanson, Plant Pathologist

Cooperation:

Colorado Agricultural Experiment Station

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USDA-ARS-NPA Sugar Beet Research Unit's Mission Statement

Utilize distinctive site environmental and disease-free characteristics and specifically developed team expertise to: develop new knowledge and adapt biotechnologies to modify host-pathogen relations that affect disease resistance, pathogenesis, and epidemiology in sugar beet and other plant species pertinent to sugar beet cultivation; discover new information and techniques to identify and produce genotypes exhibiting superior disease and stress tolerance and agronomic qualities; and provide new knowledge that improves production efficiency and biochemical processing characteristics of sugar beet.

USDA-ARS -NPA COLORADO-WYOMING RESEARCH COUNCIL

The Sugar Beet Research Unit is a part of the Colorado-Wyoming (CO-WY)Research Council. This Council was chartered to promote and coordinate cooperative research activities among CO-WY Council research units; and facilitate communication and interaction with the Northern Plains Director, and among research programs and units and with customers locally, regionally, nationally and internationally. The five research units listed below publish an annual compilation of research reports. Many of the units are considering or have placed these reports on individual home pages which can be accessed through the NPA home page at **www.npa.ars.usda.gov**.

Rangeland Resource Research Unit (RRRU) - Cheyenne, WY, Fort Collins, CO & Nunn, CO
MISSION STATEMENT: The mission of the Rangelands Resources Research Unit is to develop an understanding of the interrelationships of the basic resources that comprise rangeland ecosystems. Research is directed toward the development of science and technology that contributes to enhanced forage and livestock production and sustainable, productive rangelands in the Central Great Plains.

Central Plains Resources Management Research Unit (CPRMRU)- Akron CO.
MISSION STATEMENT: To enhance the economic and environmental well-being of agriculture by development of integrated cropping systems and technologies for maximum utilization of soil and water resources. Emphasis is on efficient use of plant nutrients, pesticides, and water and soil conservation/preservation.

Great Plains Systems Research Unit (GPSRU) - Fort Collins, CO.
MISSION STATEMENT: Help develop and implement sustainable and adaptive agricultural systems by: (1) synthesizing, quantifying, evaluating, and enhancing knowledge of processes; (2) developing integrated models of agricultural systems; (3) providing technology packages to agricultural communities and action agencies.

Ronald F. Follet, Research Leader (SPNRU)
Federal Bldg 301 S. Howes, Room 407
Fort Collins, CO 80522
TEL: (970) 490-8200
FAX: (970) 490-8213
Email: rfollet@lamar.colostate.edu

Dale F. Heerman, Research Leader (WMRU)
Agricultural Engineering Research center
Colorado State University
Fort Collins, CO 80523
TEL: (970) 491-8511
FAX: (970) 491-8247
Email: dale@lily.aerc.colostate.edu

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Soil-Plant-Nutrient Research Unit (SPNRU) - Fort Collins, CO.
MISSION STATEMENT: To develop and evaluate new knowledge required to efficiently manage soil, fertilizer and plant nutrients (emphasis on nitrogen) to achieve optimum crop yields, maximize farm profitability, maintain environmental quality and sustain long-term productivity.

Water Management Resources Unit (WMRU) - Fort Collins, CO.
MISSION STATEMENT: Research emphasis is to integrate applied and basic principles to develop improved water, chemical, and alternative weed management systems and irrigation system designs. Improvements are directed toward sustainable, environmentally sound and efficient systems based on soil, water, fertility, energy, and weed ecology principles. This encompasses understanding physical and biological phenomena and developing computer simulation models and precision farming systems to transfer new technologies to producers, consultants, action agencies, industry, and scientists.

For a copy of the Colorado-Wyoming (CO-WY)Research Council Annual Report or information on any of these programs, please note the following contacts:

Jack Morgan
Rangeland Resources Research Unit (RRRU)
Crops Research Laboratory
1701 Centre Avenue
Fort Collins, CO 80526-2083
Phone: 970 498-4216
FAX: 970 482-2909
E-Mail: morgan@lamar.colostate.edu

Randy L. Anderson, Research Leader (CPRMRU)
Central Great Plains Research Station
40335 County Road GG
P.O. Box 400
Akron, CO. 80720
TEL: (970) 345-2259
FAX: (970) 345-2088
Email: rlander@lamar.colostate.edu

Lajapat R. Ahuja, Research Leader (GPSRU)
Federal Bldg 301 S. Howes, Room 353
P. O. Box E
Fort Collins, CO 80522
TEL: (970) 490-8300
FAX: (970) 490-8310
Email: ahuja@gpsr.colostate.edu

Evaluation of Contributed Lines For Resistance to *Rhizoctonia solani*, a Causal Fungus of Sugar Beet Root Rot – BSDF Project 903

Linda E. Hanson and L. Panella
Fort Collins, Colorado

Annually, for over thirty years, the sugar beet breeding program in Fort Collins has included the production of an artificial epiphytotic through inoculation with *Rhizoctonia solani* to evaluate and select for resistance to root rot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF.

In 2001 the project involved field studies conducted at the Crops Research Lab-Fort Collins Research Farm near Wellington, CO. Randomized, complete-block designs with five replicates were used to evaluate ARS breeding germplasm and PI accessions. *Rhizoctonia*-resistant line FC703, highly resistant FC705-1, and highly susceptible FC901/C817 were included as internal controls.

One-row plots, planted May 25th, were 14 feet long with 22 inches between rows and 8-10 inches within-row spacing. Inoculation with dry, ground, barley-grain inoculum of *Rhizoctonia solani* AG2-2 isolate R-9 was performed on July 20th; immediately after inoculation, a cultivation was performed so as to throw soil into the beet crowns. The field was sprayed three times with Betamix Progress (June 27, July 6 and July 13) and twice with Upbeet (June 27 and July 6) and Stinger (July 6 and July 13) to control weeds. The field was thinned by hand and irrigated as necessary. Beets were harvested September 4 through 7. Each root was rated for rot on a scale of 0 to 7 (dead) as previously described. ANOVAs were performed on disease indices (DIs), percent healthy roots (classes 0 and 1 combined), and percentage of roots in classes 0 thru 3. Percentages were transformed to arcsin-square roots to normalize the data for analyses. LSDs are provided for comparing entries with those of our internal checks.

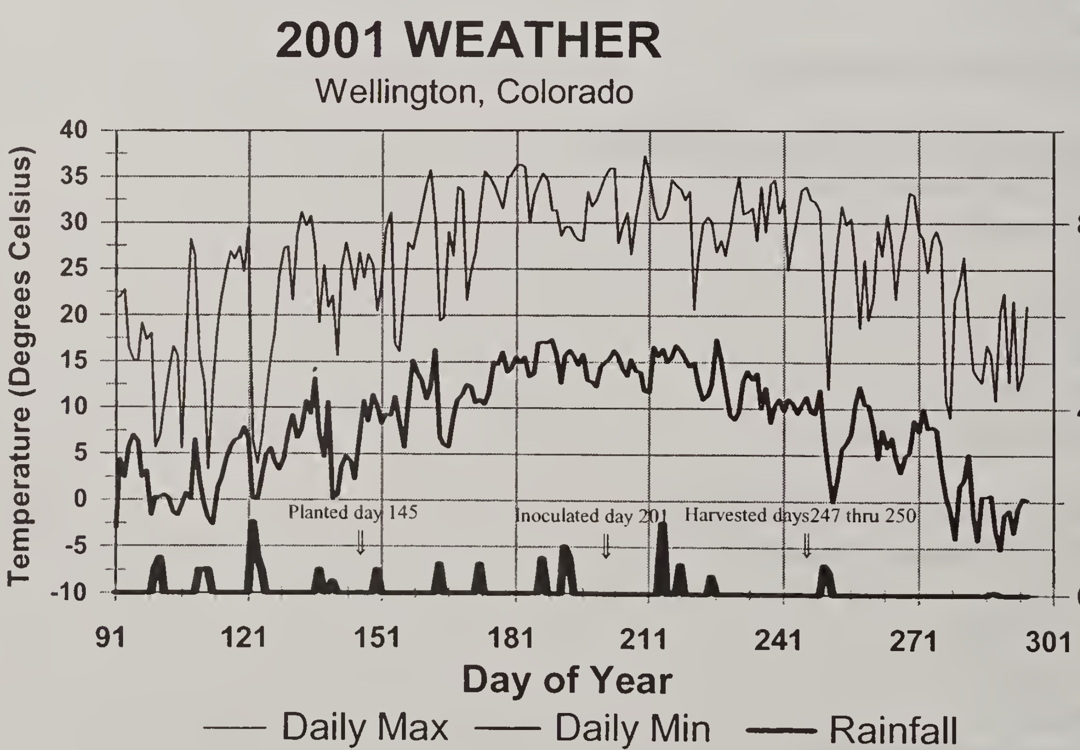

Figure 1. Summary of the weather data for 2001 Rhizoctonia root rot nursery.

The high temperatures in the summer of 2001 (Figure 1), combined with a moderate inoculum load, contributed to a severe root rot epidemic. Severe disease developed by early September. Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and highly susceptible FC901/C817 controls were 1.7, 2.2, and 4.4 respectively. Percentages of healthy roots were 46.5, 34.2, and 10.4% for these controls. Percentages of roots in disease classes zero thru three were 85.9, 74.1, and 29.8, respectively. The highest and lowest DIs for the evaluated lines were 6.9 and 1.3, respectively.

USDA-ARS 2001 Rhizoctonia Disease Nursery, Fort Collins, CO.

Table 1. Summary data of the entire 2001 Rhizoctonia root rot nursery. The experiment mean, the mean of the susceptible check, the mean of the resistant check, and the mean of the highly resistant check are given for each of the experiments in the nursery. LSD is at the t=0.05 level.

	Disease Index					Percent Healthy (classes 0&1)					Percent in Classes 0 to 3				
Exp.	Mean	Sus.	Res.	H. Res.	LSD	Mean	Sus.	Res.	H. Res.	LSD	Mean	Sus.	Res.	H. Res.	LSD
1R	4.8	5.0	2.5	1.3	0.7	12.6	7.7	36.9	61.5	11.0	26.9	25.8	65.7	90.0	13.7
2R	5.2	4.7	2.6	2.2	1.0	3.0	0.0	28.6	25.7	7.4	22.8	25.7	57.9	83.4	19.6
3R	3.6	4.7	1.9	2.1	0.9	12.1	0.0	34.9	31.4	15.2	43.5	21.4	86.9	79.1	20.3
4R	3.5	4.2	1.8	1.6	0.7	22.9	18.6.	41.2	47.1	14.6	51.7	33.8	85.6	90.0	12.6
5R	4.9	5.2	2.5	1.8	0.9	5.9	3.1	22.9	41.3	10.6	21.3	15.3	68.0	83.2	16.7
7R	2.3	4.6	2.6	1.6	0.8	32.1	6.1	21.6	47.8	16.8	72.0	24.9	63.6	86.0	18.0
8R	3.8	3.8	1.9	1.5	0.8	19.1	18.7	39.2	51.9	12.7	40.1	39.6	83.7	90.0	14.4
9R	4.7	4.7	2.6	1.5	0.9	8.0	8.7	32.3	52.8	11.3	24.2	20.8	68.3	90.0	16.9
10R	2.3	2.5	1.6	1.4	0.9	36.6	30.3	50.0	58.9	21.3	68.6	61.0	86.9	81.7	19.6

Percent in Classes is the transformed value (arcsin-square root)
Mean = Experiment Mean;
Sus. = Susceptible Check (FC901/C817);
Res. = Resistant Check (FC703);
H Res. = Highly Resistant Check (FC705/1)

Evaluation of Contributed Lines For Resistance to *Cercospora beticola*, Causal Fungus of Cercospora Leaf Spot -- BSDF Project 904

Linda E. Hanson and L. Panella
Fort Collins, Colorado

The breeding program in Fort Collins has created an annual artificial epiphytotic through inoculation with *Cercospora beticola* for over forty years. This epiphytotic has been used to evaluate and select for resistance to leaf spot caused by *C. beticola*. We have been pleased to participate in and lead this cooperative research project between the ARS, Colorado State University, and the BSDF.

In 2001 the project primarily involved field studies conducted at the Crops Research Lab-Fort Collins Research Farm near Wellington, CO. Randomized complete-block designs, with three replications, were used to evaluate commercial and experimental entries. Internal controls included a highly susceptible synthetic (SP351069-0) and a resistant check (FC504CMS/FC502-2//SP6322-0). Two-row plots were 12 feet long, with 22-inch row spacing and an 8 - to 10-inch within-row plant spacing. The trial was planted on May1. Inoculation was performed on July 5 and July 16. Evaluations were made on September 3, 10, 17, and 24, with the peak of the epidemic occurring

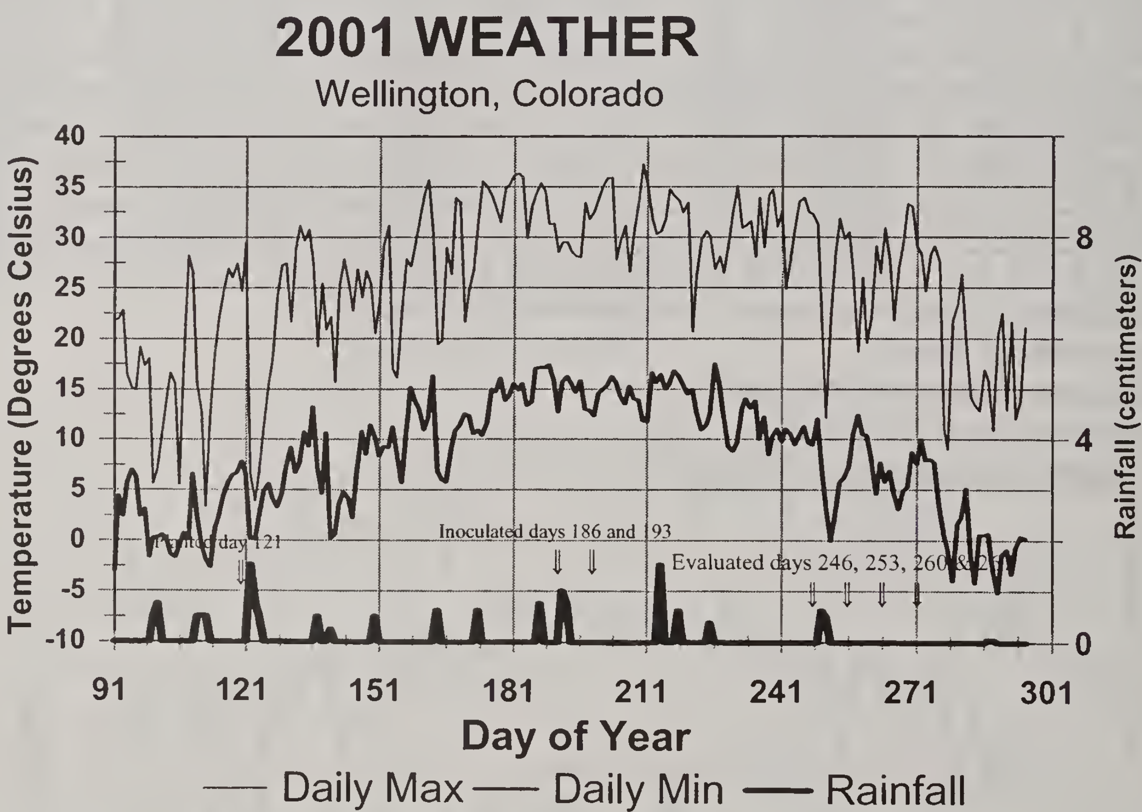

Figure 2. Summary the 2001 weather data for our Cercospora Leaf Spot Nursery.

between the last two dates. The field was sprayed three times with Betamix Progress (June 6, 14, and 27) and twice with Upbeet (June 6 and 14) and Stinger (June 14 and 27) to control weeds. The field was thinned by hand and irrigated as necessary.

The high temperatures in the summer of 2001 and moderate moisture (Figure 2) contributed to a moderate leaf spot epidemic, which did not become severe enough to rate until the end of August. Disease severity increased through mid September. By the final rating, disease severity was decreasing, so only the first three ratings are given. At our third evaluation, means of the resistant and susceptible internal control were 4.97 and 6.42 (scale of 0-10), respectively, across the nursery. In 2000 (September 14), these means were 2.40 and 3.76, respectively. Means of lines in 2001 ranged from 2.0 to 8.0.

USDA-ARS 2001 Cercospora Disease Nursery, Fort Collins, CO.

Table 2. Summary data of the entire 2001 Cercospora leaf spot disease nursery. The experiment mean, the mean of the susceptible check, and the mean of the resistant check are given for each of the experiments in the nursery, for each evaluation date.

	September 3rd Disease Index				September 10th Disease Index				September 17th Disease Index			
Exp.	**Mean**	**Sus.[1]**	**Res.[2]**	**LSD**	**Mean**	**Sus.**	**Res.**	**LSD**	**Mean**	**Sus.**	**Res.**	**LSD**
1A	3.3	4.2	2.3	1.10	4.2	5.3	3.7	1.11	5.5	7.0	5.3	1.17
2A[3]	3.0	4.0	2.5	0.89	3.9	5.0	3.0	1.11	4.6	6.0	4.5	1.04
3A	3.3	4.3	3.0	0.89	4.1	6.0	4.3	1.04	5.2	7.7	5.3	0.94
4A	2.9	4.0	3.0	0.65	4.0	6.0	4.3	1.18	4.8	6.3	5.3	1.01
5A	2.8	4.0	1.0	0.96	3.1	4.0	2.0	1.38	5.0	5.7	4.5	1.27
6A	3.0	4.0	3.0	0.70	4.0	5.7	4.0	1.26	4.9	6.5	5.3	1.03
7A	2.7	4.3	2.7	1.05	3.4	5.3	2.3	1.23	4.7	6.0	4.8	1.15
8A	3.6	4.7	1.7	0.98	4.9	6.2	3.0	1.35	6.0	6.8	4.7	0.90
9A[3]	2.4	3.5	2.0	ns	2.7	4.5	3.5	1.73	3.6	5.8	5.0	1.39
Mean	**3.00**	**4.11**	**2.36**		**3.81**	**5.33**	**3.34**		**4.92**	**6.42**	**4.97**	

[1]Cercospora Susceptible Check - SP351069-0
[2]Cercospora Resistant Check - FC 504CMS/FC 502-2//SP6322-0
[3]There were only two replications of Experiment 2A & 9A.

Screening Biological Control Agents For *Rhizoctonia solani* Control on Sugar Beets – BSDF Project 420

Linda E. Hanson[1], Lee Panella[1], Amy L. Hill[1], Gail M. Preston[2]
Fort Collins, Colorado[1] and Oxford, UK[2]

Rhizoctonia root and crown rot (caused by the fungus *Rhizoctonia solani* Kühn) is the most common and most serious fungal root disease of sugar beet in the United States. The disease is endemic in beet producing areas of the United States. *Rhizoctonia solani* also causes a damping-off in sugar beet seedlings. If the infection is light, the fungus may cause crown rot or dry rot canker on maturing roots later in the season. Thus control of this fungus in the seedling stage might offer some reduction in disease later in the season, as well as improving crop stands.

Biological control can provide an alternative to chemical pesticides which are the subject of increasing regulation and restrictions due to environmental and public health concerns. Biological control is compatible with host genetic resistance and thus can be used in an IPM program. While resistance to *R. solani* is available, it does not provide complete immunity and resistance is not well expressed in seedlings, thus the addition of other control methods is desirable.

In 2001, four *Pseudomonas fluorescens* strains (PMS382, F113, SBW25, and ΔWSP) were provided by G.M. Preston. All four strains showed biological control activity against *Pythium ultimum* in Dr. Preston's work. *Trichoderma virens* strains included two strains (G-6 and G-4) from Texas cotton field soil with activity against damping-off in cotton, four UV-mutants of strain G-6, three (AB1-5, G6-23 and G6-32) with biological control activity on cotton and one (AB1-4) without biological control activity, and one isolate obtained from sugar beet, SB-1. In addition, three *T. koningii* strains (Tk-7, TkG-12, and TkG18) and one *T. atroviride* strain were used in tests. Additional strains from sugar beet are being obtained and will be included in future tests.

In *in vitro* antibiosis tests against *R. solani*, one of the *P. fluorescens* strains, PMS382, gave the greatest inhibition, but all bacterial isolates inhibited *R. solani* growth on PDA. PMS382 also inhibited the growth of all strains of *Trichoderma* examined. The three other *P. fluorescens* strains did not significantly inhibit growth of any of the *T. virens* strains, indicating that these bacterial and fungal strains may be used in combination. Growth of *T. atroviride* and *T. koningii* was inhibited by F113, but not by SBW25 or ΔWSP. None of the *Pseudomonas* strains were significantly inhibited by any of the fungal strains.

In antibiosis tests against *R. solani*, *T. virens* strains G-6, G6-23, G6-32 and SB-1 inhibited *R. solani*, while G-4, AB1-5, and AB1-4 showed no inhibitory activity. Strain G-6 is a "q" strain of *T. virens* that produces the antibiotic gliotoxin, which has activity against *R. solani* (Howell *et al.* 1993). Strain G-4 is a "p" stain of *T. virens* that produces the antibiotic gliovirin, which has activity against *Pythium ultimum* (Howell & Stipanovic 1983), but not against *R. solani*. Our results suggest that SB-1, which we isolated from sugar beet roots, is a "q" strain. This is being confirmed by analysis of secondary metabolites by Dr. L.S. Puckhaber (College Station, TX). The *T. atroviride* strain and *T. koningii* strain Tk-7 showed no inhibition of *R. solani in vitro* while *T. koningii* strains TkG12 and TkG18 showed weak inhibition of *R. solani*.

With the exception of strains AB1-4 and AB1-5, all strains of *T. virens* and *T. koningii* and the *T. atroviride* strain were mycoparasitic on *R. solani* on soil extract agar plates. Strains AB1-4 and AB1-5 did not show mycoparasitism *in vitro*.

In greenhouse tests for biological control activity, seed treatment with wheat bran/peat moss preparations of G-6 resulted in significantly increased seedling survival in all tests. Table 1 shows

emergence and survival rates from one of these tests. Seed treatment with SB-1 or G-4 each resulted in significantly increased seedling survival in two of three tests, but survival was lower than with G-6. Strain AB1-5 showed significantly increased seedling survival in the one test in which it was used, with survival levels similar to those for G-6. No significant increase in survival was observed with AB1-4, G6-23 or G6-32 in any tests. All of the *T. virens* strains colonized the root system well. No significant disease control was observed when the *T. atroviride* strain was used.

Table 3. Emergence and survival of sugar beet (FC901) seedlings with and without *R. solani* (AG2-2) treated with a wheat bran + peat moss preparation of *T. virens* strain G-6 or with the wheat bran + peat moss carrier alone.

Treatment	Percent emergence[1]	Percent survival[2]
Carrier control	52 a[3]	52 a
G-6	67 a	67 a
R. solani	19 b	11 b
G-6 + *R. solani*	48 a	48 a

[1] Average percent emergence from three replicates 14 days after planting.
[2] Average percent seedling survival from three replicates 14 days after planting.
[3] Percentages followed by the same letter are not significantly different by Fischer's LSD (α=0.05).

Possible growth promotion was observed with all four *P. fluorescens* strains, although no significant increase in seedling survival was detected in the first test with these strains. This is being repeated and tests will be conducted to examine potential growth promotion.

Rhizoctonia Root Rot Resistance And Development of Genetic Resistance in Sugar Beet - BSDF Project 440

L. Panella & L. E. Hanson
Fort Collins, Colorado

This facet of the USDA-ARS Fort Collin's sugar beet breeding program has as its goals: 1) the understanding the genetics of the *Rhizoctonia solani*/sugar beet interaction in order to better facilitate development of germplasm with high levels of resistance to Rhizoctonia and other sugar beet diseases, and 2) to provide the knowledge to better manage this disease in sugar beet production areas. It is an integrated research program with greenhouse, laboratory, and field components. Genetic information developed previously in our research is used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our cyclic improvement program. Germplasms in various stages of improvement are evaluated for resistance in inoculated field tests. Results of these tests form the basis of decisions about specific germplasm, i.e., retain, shelve, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement are identified and released for use by other sugar beet breeders.

2001 Field Research on Rhizoctonia Root Rot of Sugar Beet.

Annually, for over thirty years, the breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Rhizoctonia solani* to evaluate and select for resistance to root rot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted at the Crops Research Lab-Fort Collins Research Farm near Wellington, CO. Randomized, complete-block designs with five replicates were used to evaluate ARS breeding germplasm and Plant Introduction accessions. *Rhizoctonia*-resistant line FC703, highly resistant FC705-1, and highly susceptible FC901/C817 were included as internal controls.

One-row plots, planted May 25th, were 14 feet long with 22 inches between rows and 8-10 inches within-row spacing. Inoculation with dry, ground, barley-grain inoculum of *Rhizoctonia solani* AG2-2 isolate R-9 was performed on July 20th; immediately after inoculation, a cultivation was performed so as to throw soil into the beet crowns. The field was sprayed three times with Betamix Progress (June 27, July 6 and July 13) and twice with Upbeet (June 27 and July 6) and Stinger (July 6 and July 13) to control weeds. The field was thinned by hand and irrigated as necessary. Beets were harvested September 4 through 7. Each root was rated for rot on a scale of 0 to 7 (dead) as previously described. ANOVAs were performed on disease indices (DIs), percent healthy roots (classes 0 and 1 combined), and percentage of roots in classes 0 thru 3. Percentages were transformed to arcsin-square roots to normalize the data for analyses. LSDs are provided for comparing entries with those of our internal checks.

The high temperatures in the summer of 2001 (Figure 1), combined with a moderate inoculum load, contributed to a severe root rot epidemic. Severe disease developed by early September. Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and highly susceptible FC901/C817 controls were 1.7, 2.2, and 4.4 respectively. Percentages of healthy roots were 46.5, 34.2, and 10.4% for these controls. Percentages of roots in disease classes zero thru three were 85.9, 74.1, and 29.8, respectively. The highest and lowest DIs for the evaluated lines were 6.9 and 1.3, respectively.

Table 4. Allotment of Fort Collins "FC" numbers (3-digit numbers)
"FC" numbers are "convenience" numbers for "seed releases" or purposes where a permanent line designation is needed — i.e. a number that does not change from generation to generation where little or no selection pressure is applied. Initially, an "FC" no. was written thus "FC 501" [now FC727], "FC 502 CMS" [now FC715CMS], etc. Sublines (from selfing) were designated thus, "FC 502/2" [now FC709-2], "FC502/3" [now FC502-3], etc. The same applies when the line is substantially changed by selection without selfing.

Below 500	Originally LeRoy Powers - now parental lines and special genetic stocks.
500's	Leaf Spot Resistant (LSR), Type-O lines & male steriles [CMS]
600's	LSR-Curly Top Resistant (CTR), type-O lines & male steriles [CMS]
700's	Rhizoctonia Resistant
800's	LSR-CTR-Rhizoctonia resistant
900's	Pollinators, LSR-CTR type

This year, I also completed a second year of evaluation of most of the Rhizoctonia-resistant lines released from the USDA-ARS breeding project at Fort Collins (Table 6). This is a test from 2000 under the same conditions as the other contributor lines in this year's test.

Rhizoctonia-Resistant Populations Under Development

Root rot and leaf spot are two serious diseases of sugar beets caused by fungi (*Rhizoctonia solani* and *Cercospora beticola*, respectively). The diseases caused by these fungi may produce a severe reduction of yield in many sugar beet production areas. Cultural control measures are not adequate by themselves, and often no chemicals are registered for control of these diseases, or chemical control is expensive or environmentally unsafe. Increased levels of genetic resistance in sugar beet varieties are needed to minimize growers' losses from these diseases. In a hybrid crop like sugar beets, it is preferable that all of the parents contain some level of resistance to diseases prevalent in the area in which the hybrid is to be grown. Multiple disease resistance is a difficult goal in a crop improvement program, especially when working with an outcrossing species. In alternating generations of selection, some of the progress made in resistance to one disease is lost while selecting for resistance to other diseases.

One way of solving the problem of selecting for multiple disease resistance is the use of progeny testing. By testing the progeny of individual mother roots, plants with multiple disease resistance can be identified and used as parents of the next generation. The most efficient use of progeny testing is when the genotype of both parents is controlled, and the most effective way to do

this is through self-pollination. In sugar beet, there is a dominant, self-fertility gene that permits self-pollination. Used in conjunction with genetic male sterility, to insure cross pollination, a system of selfed-family progeny testing can be utilized.

This effort is based on the Rhizoctonia-resistant materials from the programs of John Gaskill and Richard Hecker, and disease resistant germplasm from other sources to produce germplasm highly resistant to *Rhizoctonia solani*. This base of Rhizoctonia-resistant germplasm is being combined with material from the USDA-ARS breeding programs at Salinas and Fargo, as well as with sources for higher yield and sucrose. The Salinas material has the self-fertility allele, is segregating for genetic male sterility, and also contains a broad spectrum of resistance to diseases of importance in California as well as other sugar beet production areas (including rhizomania, powdery mildew, virus yellows, and curly top virus). Fargo sources of root maggot and Cercospora leaf spot resistance also are being utilized.

A number of source populations are being developed. The germplasm, FC712(4X) has been released in 2000. This germplasm was developed in our research project that has been contributed to, in kind, by the Beet Sugar Development Foundation. This tetraploid pollinator germplasm combines excellent Rhizoctonia-root-rot resistance with a good level of Cercospora leaf spot resistance. Populations whose development was begun under the breeding program of Dr. Richard Hecker were evaluated and selected in the field. These germplasms and other germplasms from the USDA-ARS Fort Collins breeding program, the USDA-ARS Salinas breeding program and the USDA-ARS East Lansing breeding program were field-tested in summer of 2001 for resistance to *R. solani* (Table 5). More germplasms that were selected for increased resistance to Rhizoctonia-root-rot in 2000, and tested in 2001, will be tested again in 2002. These will be looked at for resistance and agronomic quality, and the most promising of these will be released in the future.

There currently are four major groups of Rhizoctonia-resistant germplasms currently under development.

1. Germplasms developed in Dr. Hecker's breeding program for resistance to Rhizoctonia root rot and Cercospora leaf spot are being field tested and selected in the Rhizoctonia root rot nursery at Fort Collins (also in the Cercospora leaf spot and curly top nurseries).

2. Rhizoctonia-resistant monogerm polycross base population developed by a cross between FC708 and two Salinas germplasms, 2890 and 2859.
   A. 2890 (sp) 0790 *mm aa* x 1890 (Salinas); is seed from *aa* plants [i.e., male sterile] open pollinated by A- plants. 0790 = population-790 cycle 5 synthetic by S_1 progeny, M.S. mm, O-type, good combining ability, adapted to California, S^f,. 1890 = BC population to population 790 to get Rz equivalent, remains variable for M-:mm, Rz-:rzrz, etc.
   A. 2859 m (sp) = 1859, 1859R aa x A- (Salinas); Released in 1992 as C859. S^f, similar to 2890, but should have higher curly top resistance (CTR). Segregates and variable for M-:mm, Rz-:rzrz, A-:aa, predominant background is lines like C563, which is widely used in western USA as source of CTR, mm, O-type.

3. Rhizoctonia root rot resistance multigerm base population developed by a cross between FC709-2 and a Salinas germplasms, 2915.
   A. 2915 (sp) RZM 1915-#m 1913-# aa x A (Salinas); Seed harvested from aa (ms) plants open-

pollinated by A- (fertile) plants. This population will segregate for A-:aa, Rz-:rzrz, s^ss^s:s^f-, (>½ s^f), R-:rr, It will be multigerm, have moderate to good tolerance to virus yellows, curly top, bolting, Erwinia; variable for reaction to powdery mildew, production traits. Individual plants will be either As or aa. Background of population is mostly from OP, MM lines such as C46, C37.

4. Combination Rhizoctonia root rot and Cercospora leaf spot resistant multigerm pollinator population from FC907 (out of Fargo) and FC709-2.

<u>Progress in 2001</u>

1. Selections have been made in these populations and they have been crossed with other germplasm in a continuing *Rhizoctonia*-resistance breeding effort. One tetraploid multigerm pollinator [FC712 4(X)] was released last. It has excellent resistance to Rhizoctonia root rot and good Cercospora resistance. Three to five monogerm O-type lines with and without and CMS equivalents, selected in the 1996 Rhizoctonia nursery were re-tested and increased and will be released this fall.

2. This population (FC708/2890&2859) has been divided into three breeding lines. One has been selected for resistance to curly top (selfed progeny tested in Kimberley, ID) and Rhizoctonia (individual plants selected in the Fort Collins nursery), and is currently being increased for testing and re-selection. Another population has been selected for resistance only to Rhizoctonia (individual plants selected in the Fort Collins nursery), and is currently being increased for testing and re-selection. The third line was selected for Rhizomania resistance and agronomic performance (individual plants selected in the Salinas nursery) and is currently being re-selected and recombined for further testing (August 2000 planting in Salinas).

3. This population (FC709-2/2915) has been divided into four breeding lines selected in Fort Collins, CO, and Kimberley, ID. Two have been selected for resistance to Rhizoctonia (individual plant selections and half-sib families selections), one was selected for resistance to Rhizoctonia and curly top virus (half-sib families selections), and one was selected for resistance to curly top (half-sib families selections). Three of the populations were planted in Dr. R. Lewellen's Rhizomania/steckling nursery for selection for resistance to rhizomania (Holly gene source) and for agronomic performance. Selected roots will be increased for further sucrose and rhizomania testing, selection, and release.

4. Seed, increase from Rhizoctonia-resistant selected roots of FC907 ((FC701 x FC607)BC_4), was tested in the Rhizoctonia and Cercospora nurseries. Selections made in a (FC709-2 x FC907)F_2 population in the Rhizoctonia were increased in the greenhouse and tested in the Rhizoctonia and curly top nurseries. This population will be re-selected in the Rhizoctonia nursery and then tested in the Rhizoctonia, Cercospora, and curly top nurseries and evaluated for release.

Table 5. Experiment 4R, 2001. Rhizoctonia Resistance Evaluation of USDA-ARS contributed lines.

Entry	Description		DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
	LSD[5]		**0.66**			**14.58**	**12.60**
821	**Susceptible Check[6]**		**4.2**	**13**	**32**	**18.6**	**33.8**
822	**Highly Resistant Check[7]**		**1.6**	**53**	**100**	**47.1**	**90.0**
823	**Resistant Check[8]**		**1.8**	**44**	**97**	**41.2**	**85.6**
	Experiment Mean		**3.5**	**22**	**57**	**22.9**	**51.7**
791	EL	02042	5.1	3	12	4.2	18.1
792	SR96	(95HS6)	5.8	1	5	2.6	11.6
793	SR95		5.5	1	10	3.1	14.2
794	SR94		4.9	9	18	15.3	24.5
795	SR93		4.9	5	17	8.4	21.5
796	SR80		4.6	9	32	14.5	33.5
797	SR87		4.4	8	39	13.8	38.2
798	94HS25		5.3	6	18	9.3	21.6
799	99J19	00mm	4.1	15	42	20.2	40.5
800	98J26	052 mm	3.2	22	63	25.0	56.0
801	99J31	00 mm	4.1	11	42	17.2	40.6
802	Inc. R539	(C39R)	5.9	2	9	3.9	12.7
803	RZM 99	EL0204 (SR)	5.2	0	10	0.0	16.6
804	RZM - %S	FC951014	3.3	19	61	22.3	51.8
805	RZM 99	FC123	6.0	1	3	3.1	6.1
806	921024		1.6	57	99	49.6	87.2
807	961015		1.7	48	100	43.7	90.0
808	951016HO		2.1	38	95	37.8	82.1
809	951016HO	1	1.7	55	100	48.1	90.0
810	961010HO		2.0	32	97	34.2	85.1
811	961010HO	1	2.3	23	97	22.7	85.6
812	961014		1.7	52	100	45.8	90.0
813	991011		1.8	60	90	51.3	75.9
814	20001002		3.7	10	60	11.5	51.8
815	20001008		2.7	13	88	16.6	74.1
816	20001009		3.8	13	57	16.4	49.4
817	20011003	HO	2.4	31	84	30.8	67.3
818	20011013	HO1	2.3	36	83	36.4	66.3
819	20011013H		3.7	11	55	17.0	47.7
820	200011016		3.4	18	53	23.8	46.8

[1]Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).
[2]Percent of healthy roots (disease classes 0 and 1 combined).
[3]Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined).
[4]Percentages were transformed to arcsin-square roots to normalize the data for analyzes.
[5]P=0.05
[6]FC901/C817
[7]FC705/1
[8]FC703

Table 6. Experiment 7R, 2001. Rhizoctonia Evaluation of USDA-ARS Fort Collins Released Germplasm.							
	Seed Source	Release	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		(<3.84) LSD[5]	**0.76**			**16.79**	**17.96**
Susceptible Check[6]		**941025**	4.6	3	23	6.1	24.9
Experiment Mean			2.3	33	83	32.1	72.0
	97A004	EL 48	3.9	14	43	16.4	40.9
	96A009	EL 50	2.6	32	72	31.1	62.2
	99A003	EL 52	3.0	18	67	20.1	56.6
	931024	FC701	3.1	21	56	23.0	49.3
	761068H	FC701-4	2.2	43	81	38.0	72.7
	721056	FC701-5	2.2	41	83	36.4	69.5
	801059H	FC701-6	1.5	57	99	49.1	86.9
	681009-0	FC702	3.0	4	64	5.3	59.3
	19991016	FC702-2	2.0	38	90	37.8	74.1
	811055H	FC702-6	1.6	53	100	47.0	90.0
Resistant Check	**751080H**	**FC703[8]**	**2.6**	**21**	**76**	**21.6**	**63.6**
	19991017	FC703	1.9	50	90	44.4	81.0
	931021	FC704	5.7	0	10	0.0	11.9
	20001018	FC704	2.7	21	75	20.0	64.2
	781066H	FC705	1.8	38	97	37.6	83.5
	20001019	FC705	1.9	40	93	38.9	82.6
Highly Resistant Check	**831083**	**FC705/1[7]**	**1.6**	**55**	**98**	**47.8**	**86.0**
	20001020	FC706	2.4	27	75	27.7	63.5
	20001021	FC707	1.9	42	89	39.7	73.1
	831085HO	FC708	1.7	44	97	38.2	85.1
	891026H	FC709	1.4	68	98	59.5	86.1
	19991018	FC709	1.6	54	96	47.8	82.5
	921024	FC709-2	1.4	66	100	57.3	90.0
	891033	FC710	1.6	54	97	47.2	83.5
	971017	FC710(4X)	2.5	15	87	15.0	79.0
	821087	FC711	3.0	7	69	9.7	58.0
	19991019	FC711	2.7	17	72	21.5	62.3
	881032H	FC712	1.4	62	99	53.0	87.4
	971018	FC712(4X)	1.6	45	100	41.2	90.0
	911026HO	FC715	2.3	39	87	38.5	71.8
	971019	FC716	1.7	48	98	43.0	84.4
	911031	FC717	2.5	24	81	28.3	66.8
	911032	FC718	2.5	18	80	21.2	66.4
	911037	FC719	2.2	25	88	28.8	69.8
	961015	FC720-1	1.7	47	99	43.3	87.4
	961010HO	FC722-1	2.4	17	85	19.0	72.1
	961010HO1	FC722CMS	2.4	13	95	16.3	84.0
	951016HO	FC723	2.1	38	91	37.1	79.3
	951016HO1	FC723CMS	2.1	27	93	29.9	74.7
	961014	FC724-1	1.7	41	99	38.8	87.2
	921008	FC725	1.4	56	100	49.0	90.0
	931010	FC726	1.9	39	95	37.9	79.8
	951017	FC727	2.1	34	87	34.5	74.5

Table 6. Experiment 7R, 2001. Rhizoctonia Evaluation of USDA-ARS Fort Collins Released Germplasm.							
	Seed Source	Release	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		(<3.84) LSD[5]	**0.76**			**16.79**	**17.96**
Susceptible Check[6]		**941025**	4.6	3	23	6.1	24.9
	921025	FC728	2.0	34	92	34.4	77.5
	921019	FC729	1.8	45	93	42.1	80.1
	19991015	FC801	2.8	14	75	17.2	62.7
	971020	FC907-1	4.1	9	32	11.2	30.9
	931005HO	FC721	2.3	22	88	24.8	74.6
	931005HO1	FC721CMS	2.0	26	97	30.0	85.6

[1]Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).
[2]Percent of healthy roots (disease classes 0 and 1 combined).
[3]Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined).
[4]Percentages were transformed to arcsin-square roots to normalize the data for analyzes.
[5]P=0.05
[6]FC901/C817
[7]FC705/1- highly resistant check
[8]FC703 - resistant check

Cercospora Leaf Spot Research And Breeding For
Cercospora And Curly Top Resistance - BSDF Project 441

L. Panella & L. E. Hanson
Fort Collins, Colorado

This element of the breeding program at Fort Collins is devoted to the development of germplasm with resistance to more than one sugar beet disease and improved agronomic characteristics. It is built on germplasm developed at Fort Collins over the last fifty years for combined resistance to Cercospora leaf spot and the curly top virus. This is an integrated breeding program with greenhouse and laboratory studies, and a field program based on testing in an artificial epiphytotic created in the unique Fort Collins environment. It involves close collaboration with the other USDA-ARS sugar beet programs in the U.S. and sugar beet seed industry customers. The major goals of this program are: 1) the development of sugar beet germplasm with resistance to more than one disease and excellent agronomic characteristics; 2) the improvement of breeding techniques, traditional and molecular, to develop this germplasm; and 3) an increased understanding of the sugar beet/pathogen interactions to improve management practices of these diseases in sugar beet production areas. Genetic information developed during this research will be used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our leaf spot improvement program. Results of these tests will be the basis of decisions about specific germplasm, i.e., retain, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement will be identified and released for use by other sugar beet breeders.

Increased resistance to *Cercospora* continues to be an extremely important goal. If the level of resistance available in most Cercospora-resistant experimental lines were present in commercial hybrids (along with good sugar and seed yield), the need for fungicides would be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed is evident by the occurrence of *Cercospora* strains that are resistant or increasingly tolerant to our most potent fungicides. Additionally, some of these fungicides may be removed from the market because of their perceived or real threat to the environment. In many areas where Cercospora leaf spot is a problem, the curly top virus also causes significant losses. And, there are some growing areas in which combined resistance to Cercospora leaf spot, Rhizomania, curly top, Rhizoctonia root rot, and other diseases are desirable. Germplasm is needed with combined resistance to these diseases, along with good combining ability for yield components.

2001 Field Research on Cercospora Leaf Spot of Sugar Beet

The breeding program in Fort Collins has created an annual artificial epiphytotic through inoculation with *Cercospora beticola* for over forty years. This epiphytotic has been used to evaluate and select for resistance to leaf spot caused by *C. beticola*. We have been pleased to participate in and lead this cooperative research project between the ARS, Colorado State University, and the BSDF.

In 2001 the project primarily involved field studies conducted at the Crops Research Lab-Fort Collins Research Farm near Wellington, CO. Randomized complete-block designs, with three replications, were used to evaluate commercial and experimental entries. Internal controls included a highly susceptible synthetic (SP351069-0) and a resistant check (FC504CMS/FC502-2//SP6322-0). Two-row plots were 12 feet long, with 22-inch row spacing and an 8 - to 10-inch within-row plant

spacing. The trial was planted on May1. Inoculation was performed on July 5 and July 16. Evaluations were made on September 3, 10, 17, and 24, with the peak of the epidemic occurring between the last two dates. The field was sprayed three times with Betamix Progress (June 6, 14, and 27) and twice with Upbeet (June 6 and 14) and Stinger (June 14 and 27) to control weeds. The field was thinned by hand and irrigated as necessary.

The high temperatures in the summer of 2001 and moderate moisture (Figure 2) contributed to a moderate leaf spot epidemic, which did not become severe enough to rate until the end of August. Disease severity increased through mid September. By the final rating, disease severity was decreasing, so only the first three ratings are given. At our third evaluation, means of the resistant and susceptible internal control were 4.97 and 6.42 (scale of 0-10), respectively, across the nursery. In 2000 (September 14), these means were 2.40 and 3.76, respectively. Means of lines in 2001 ranged from 2.0 to 8.0.

Cercospora/Curly Top-Resistant Populations with Resistance to Multiple Sugar Beet Diseases and Superior Agronomic Characteristics

Ten advanced smooth root germplasms from the USDA-ARS East Lansing breeding program were evaluated in Experiment 4A, 2001 (Table 7); sixteen advanced germplasms from the USDA-ARS Salinas breeding program were evaluated in Experiment 6A (Table 8); twenty-three germplasm from the USDA-ARS Fargo breeding program were evaluated in Experiment 5A; thirty-three germplasm from the USDA-ARS Fort Collins breeding program were evaluated in Experiment 7A (Table 9) and progeny families in Experiment 9A (Table 10). Breeding lines and progeny families from breeding USDA-ARS programs at Fort Collins and East Lansing were also tested at the BSDF Nursery in Kimberly, ID (Tables 11, 12, and 13).

<u>Germplasm under Development</u>:

Cercospora Leaf Spot/Curly Top Resistant (LSR/CTR) Breeding Populations Currently under Development.

5. Cercospora leaf spot and curly top resistant monogerm base population from a polycross of FC607 and FC604 with two Salinas germplasms 2859 and 2890.
    - B. 2890 (sp) = 0790 *mm aa* x 1890 (Salinas); is seed from *aa* plants open pollinated by A- plants. 0790 = population-790 cycle 5 synthetic by S_1 progeny, *aa*, mm, O-type, good combining ability, adapted to California, S^f. 1890 = BC population to population 790 to get Rz equivalent, remains variable for M-:mm, Rz-:rzrz, etc.
    - C. 2859 m (sp) = 1859, 1859R aa x A- (Salinas); Released in 1992 as C859. S^f, similar to 2890, but should have higher curly top resistance. Segregates and variable for M-:mm, Rz-:rzrz, A-:aa, predominant background is lines like C563.

6. Cercospora leaf spot and curly top resistant multigerm base population from a polycross of FC902 with two Salinas germplasms 278 and 4918.
    - A. 278 (Iso 83) = RZM R078; R278 is Rz (segregates Rz--:rzrz) version of C46. It should be S^sS^s, MM.
    - B. 4918 (sp) = RZM 3918aa X A-, 142 aa plants; This is an increase of released

material C918. It should be Multigerm, over 75% S^f and segregating for A-, R-, Rz-, VY, CT, Erw, & PM.

7. Cercospora leaf spot and curly top resistant multigerm, self-incompatible base population from a polycross of FC607 x [SR87, MonoHy A4, MonoHy T6, & MonoHy T7]

8. Seed from FC709-2 x FC907 was sent to Larry Campbell at Fargo to cross to Sugar beet root maggot resistant germplasm to develop a population that will produce pollinators with resistance to Rhizoctonia, Cercospora, and Root maggot.

9. Two tetraploid pollinators (FC6064X and FC6074X) were crossed to a high sucrose tetraploid population in order to produce a tetraploid Cercospora resistant pollinator population with better combining ability.

Progress in 2001

Advanced breeding lines of *Cercospora* resistant germplasms were evaluated in the ARS leaf spot nursery at Ft. Collins. These lines are part of the resistant germplasm development effort in which a new germplasm should be released from the "pipeline" every two to four years. The above populations currently are in different stages of development.

1. Selections were made among half-sib progeny rows (FC607&FC604/2859&2890) of the monogerm population. Families selected based on combined leaf spot and curly top resistance were increased, tested, and re-selected and sent to Salinas, CA. There they have been selected for rhizomania (Holly gene source) and agronomic performance, recombined and are being retested. Selections are also being O-type screened for release.

2. Plants (F_2) from the CTR/LSR multigerm cross (2 above – FC902/278/4918.) were tested for resistance to Rhizoctonia and Cercospora and recombined. This seed has been bulk increased and crossed with a number of other leaf spot, rhizomania resistant and high sources populations. The resulting population will be a source of curly top resistant multigerm pollinators with leaf spot and Rhizomania resistance. This cross was planted in the Salinas rhizomania resistance nursery for selection and also has been selected for agronomic performance and recombined. It will be tested and evaluated for release.

3. Plants (F_2) from the Fort Collins and Fargo joint project (3 above – FC607 x [SR87, MonoHy A4, MonoHy T6, & MonoHy T7]) were grown in the breeding nursery and these roots were planted in Masonville selfed, taking advantage of the 'pseudo self-fertility' that occurs in this environment. This selfed seed was progeny tested in 1999 and the most resistant families were recombined and are being tested and evaluated for release. This population will be a source of highly leaf spot resistant multigerm pollinators with curly top resistance and good combining ability for agronomic traits.

4. Seed from (FC709-2 x FC907)F_2 has been sent to Larry Campbell at Fargo to cross to Sugar beet root maggot resistant germplasm and be selected for Cercospora resistance. This

population will be reselected for Rhizoctonia resistance. The population will provide pollinators with resistance to Rhizoctonia, Cercospora, and Root maggot.

5. Half-sib families from this population (FC6064X & FC6074X/high sucrose 4X) will be planted in the Leaf spot nursery and selected for *Cercospora*-resistance and also tested for sucrose & yield.

The seed from the above mentioned populations will be developed and advanced after testing. Development of a resistant germplasm line generally takes 7 years. A longer time may be necessary to incorporate multiple disease resistances. In an established program, a "pipeline" of lines in various stages of development and evaluation is the norm. Hence, the release of new germplasm usually occurs every 2 to 4 years.

Genetic information developed in this research will be used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our leaf spot improvement program. Results of these tests will be the basis of decisions about specific germplasm, i.e., retain, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement are identified and released for use by other sugar beet breeders. Breeding techniques are compared in developing these germplasm and information on the efficacy and efficiency of these techniques generated.

Table 7. Experiment 4A, 2001. Leaf Spot Evaluation of USDA-ARS E. Lansing contributed lines.

			Disease Index[1]		
Entry		**Identification**	**September 3rd**	**September 10th**	**September 17th**
		$LSD_{0.05}$	**0.65**	**1.18**	**1.01**
411	**LSS [2]**	**(931002)**	**4.0**	**6.0**	**6.3**
412	**LSR [3]**	**(821051H2)**	**3.0**	**4.3**	**5.3**
Trial Mean			**2.9**	**4.0**	**4.8**
391	SR96 (95HS6)	2001 A014	2.5	3.5	4.0
392	SR95	2001 A015	3.5	4.5	6.0
393	SR94	2001 A016	3.3	4.7	5.0
394	SR93	2001 A017	3.2	4.3	5.3
395	SR80	2001 A018	2.7	4.0	5.2
396	SR87	2001 A019	2.8	4.2	5.2
397	94HS25	2001 A020	3.2	4.7	5.0
398	99J19-00mm	2001 A021	3.0	3.7	4.5
399	98J26-052 mm	2001 A022	2.0	3.3	4.0
400	99J31-00 mm	2001 A023	3.0	4.3	4.7

[1]Disease Index is based on a scale of 0 (=healthy) to10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).
Note: means and LSD are for entire plot, which included additional lines not shown on this table.

Table 8. Experiment 6A, 2001. Leaf Spot Evaluation of USDA-ARS Salinas contributed lines.

Entry	Identification	Disease Index[1] September 3rd	September 10th	September 17th
	$LSD_{0.05}$	0.70	1.26	1.03
467	**LSS[2] (931002)**	**4.0**	**5.7**	**6.5**
468	**LSR[3] (821051H2)**	**3.0**	**4.0**	**5.3**
Trial Mean		**3.0**	**4.0**	**4.9**
451	Beta 4430R	4.2	6.0	6.3
452	0931	3.3	4.7	5.2
453	CR009-1	2.2	4.0	4.8
454	CR011	2.8	3.7	4.5
455	00-EL0204	3.3	4.0	4.7
456	00-FC123	3.5	5.3	6.3
457	00-FC1014m	2.2	2.8	4.2
458	00-SP22-0	3.2	4.3	5.3
459	CR911-13	2.3	2.5	4.2
460	CR910-2 (sp)	2.7	3.7	3.7
461	CR911-7 (sp)	2.5	3.3	4.3
462	CR911-18 (sp)	3.0	3.7	4.7
463	CR911-21 (sp)	2.7	3.7	4.0
464	CR911-3 (sp)	2.8	3.8	4.8
465	CR912-6 (sp)	3.1	3.7	4.3
466	CR912-11 (sp)	2.5	3.3	4.2

[1]Disease Index is based on a scale of 0 (=healthy) to10 (=dead).

[2]The Leafspot Susceptible Check is SP351069-0.

[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 9. Experiment 7A, 2001. Leaf Spot Evaluation of USDA-ARS Fort Collins, Salinas, and East Lansing breeding lines.

Entry	Identification		Disease Index[1]			
			Sept. 3rd	Sept. 10th	Sept. 17th	Sept. 24th
		$LSD_{0.05}$	1.05	1.24	1.15	1.21
		CV	23.6	22.3	15.0	19.4
LSS[2] (931002)			4.3	5.3	6.0	5.7
LSR[3] (821051H2)			2.7	2.3	4.8	4.0
Trial Mean			2.7	3.4	4.7	3.8
(FC907 X FC709-2)-sel single family	20001008		1.7	2.3	2.7	2.3
FC715	911026HO		2.3	2.2	3.3	2.7
FC709-2	20001016HO		1.8	2.2	3.3	2.5
FC723 – EL44/FC708 mm	951016HO		2.7	2.7	3.7	2.7
FC708	831085HO		1.7	2.7	3.8	3.0
FC717	981025		2.5	2.7	3.8	3.8
(FC708CMS X FC709-2)	20001016H02		2.0	2.0	4.0	3.0
FC723 CMS – EL44/FC708 CMS	951016HO1		3.0	2.7	4.0	3.2
FC702-7	921022		2.7	3.7	4.0	3.7
LSR Polycross with East Lansing material	20011001		2.3	2.8	4.0	3.5
Sucrose MMaa population X PI535826 (Giant Poly - LSR)	991026MS		2.3	2.3	4.0	3.8
(FC907 X FC709-2)-sel multiple families	20001009		2.3	3.0	4.2	4.0
FC703-5	921021		2.7	2.5	4.2	2.5
Sucrose MMaa X LSR PI540596 - biennial maritima LSR	981032		2.7	3.7	4.3	3.7
LSR(4x) X Sucrose(4x)	20001006		3.0	3.7	4.3	4.0
Sucrose MMaa population X PI535826 (Giant Poly - LSR)	991026PF		3.2	3.2	4.5	3.3
FC907-1 – FC607/FC701 BC4	971020		2.2	3.0	4.5	3.3
LSR/CTR MM X LSR Fargo (981036)	20001004		3.2	3.7	4.8	3.5
FC712/MonoHy A4 - CMS equivalent	20011003HO1		2.8	4.2	4.8	4.2
FC722 CMS – C718/FC708 CMS	961010HO1		2.3	3.5	5.0	4.0
FC728	921025		3.2	3.8	5.2	3.7

Table 9. Experiment 7A, 2001. Leaf Spot Evaluation of USDA-ARS Fort Collins, Salinas, and East Lansing breeding lines.

Entry	Identification		Disease Index[1]			
			Sept. 3rd	Sept. 10th	Sept. 17th	Sept. 24th
		$LSD_{0.05}$	1.05	1.24	1.15	1.21
		CV	23.6	22.3	15.0	19.4
LSS[2] (931002)			4.3	5.3	6.0	5.7
LSR[3] (821051H2)			2.7	2.3	4.8	4.0
Trial Mean			2.7	3.4	4.7	3.8
FC727	951017		3.3	3.3	5.2	3.7
LSR MM with Fargo	20001007		2.7	3.7	5.3	4.8
(2859 & 2890 X FC607 & FC604) LSR	981010H		2.5	3.5	5.3	4.2
FC607	97A050		2.3	3.2	5.3	4.3
Sucrose MMaa X LSR PI540599 - annual maritima LSR	981033PF		3.3	4.8	5.3	4.7
FC607 & FC604 with 2890, 2859 (Salinas)	991003H		3.7	4.2	5.3	4.7
Rhx=zcRmm (991001) {2859 & 2890 X FC708	20011016		3.2	4.0	5.5	4.7
(2859 & 2890 X FC607 & FC604) CTR	981011H		3.3	4.0	5.5	5.0
FC506	961013HO		3.2	4.3	5.8	4.2
(2859 & 2890 X FC607 & FC604) CTR	981012		3.7	5.3	6.0	5.0
FC722-1 – C718/FC708	961010HO		2.8	5.0	6.0	5.0
FC712/MonoHy A4	20011003HO		2.7	3.5	6.0	4.0

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 10. Experiment 9A, 2001. Leaf Spot Evaluation of USDA-ARS Fort Collins progeny families.

		Disease Index[1]			
		Sept. 3rd	Sept. 10th	Sept. 17th	Sept. 24th
LSS [2]	**931002**	**3.0**	**4.0**	**5.5**	**4.0**
LSR [3]	**821051H2**	**2.5**	**4.0**	**5.5**	**4.0**
(2859 & 2890 X FC604 & FC607)	20011004 - 13	1.0	3.0	3.0	2.0
Multigerm LSR/CTR	20011017 - 24	2.5	3.0	3.5	2.5
Multigerm LSR/CTR	20011017 - 31	2.5	2.5	3.5	3.5
Multigerm LSR/CTR	20011017 - 90	2.5	2.5	4.0	3.5
Multigerm LSR/CTR	20011017 - 79	2.0	3.0	4.0	3.0
Multigerm LSR/CTR	20011017 - 50	2.5	2.5	4.0	3.5
Multigerm LSR/CTR	20011017 - 63	2.0	3.0	4.0	3.0
Multigerm LSR/CTR	20011017 - 77	2.5	3.0	4.0	3.0
Multigerm LSR/CTR	20011017 - 74	2.0	2.5	4.0	3.0
Multigerm LSR/CTR	20011017 - 72	2.5	3.0	4.0	3.5
Multigerm LSR/CTR	20011017 - 23	3.0	3.5	4.0	3.3
(2859 & 2890 X FC604 & FC607)	20011004 - 51	3.0	2.5	4.0	3.5
Multigerm LSR/CTR	20011017 - 84	2.5	3.5	4.0	3.0
Multigerm LSR/CTR	20011017 - 86	2.5	2.5	4.0	3.0
Multigerm LSR/CTR	20011017 - 8	2.5	2.5	4.0	3.0
Multigerm LSR/CTR	20011017 - 39	2.5	2.5	4.0	3.0
Multigerm LSR/CTR	20011017 - 51	2.5	3.3	4.0	3.5
Multigerm LSR/CTR	20011017 - 33	2.5	3.0	4.0	3.0
Multigerm LSR/CTR	20011017 - 17	2.0	2.5	4.0	3.0
(2859 & 2890 X FC604 & FC607)	20011005 - 52	2.5	3.0	4.0	3.5
Multigerm LSR/CTR	20011017 - 71	2.5	3.3	4.0	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 18	2.5	2.5	4.0	3.5
Multigerm LSR/CTR	20011017 - 32	2.5	3.0	4.0	2.5
(2859 & 2890 X FC604 & FC607)	20011005 - 36	2.5	3.5	4.0	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 22	3.0	3.0	4.0	3.0
Multigerm LSR/CTR	20011017 - 29	2.5	3.0	4.3	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 20	2.8	4.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 6	2.8	3.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 40	3.0	3.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 41	3.0	3.5	4.5	3.0
(2859 & 2890 X FC604 & FC607)	20011004 - 30	3.0	4.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 50	3.0	3.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 24	2.5	2.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 51	3.0	3.0	4.5	3.0
(2859 & 2890 X FC604 & FC607)	20011004 - 33	2.5	3.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 15	3.0	4.0	4.5	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 34	2.5	3.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 13	2.5	3.0	4.5	3.5
Multigerm LSR/CTR	20011017 - 82	2.5	3.5	4.5	4.0
Multigerm LSR/CTR	20011017 - 1	2.0	2.5	4.5	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 32	2.5	3.0	4.5	3.0
(2859 & 2890 X FC604 & FC607)	20011005 - 27	2.5	3.5	4.5	3.5

Table 10. Experiment 9A, 2001. Leaf Spot Evaluation of USDA-ARS Fort Collins progeny families.					
		Disease Index[1]			
		Sept. 3rd	Sept. 10th	Sept. 17th	Sept. 24th
LSS [2]	**931002**	**3.0**	**4.0**	**5.5**	**4.0**
LSR [3]	**821051H2**	**2.5**	**4.0**	**5.5**	**4.0**
(2859 & 2890 X FC604 & FC607)	20011005 - 9	2.5	3.0	4.5	3.5
Multigerm LSR/CTR	20011017 - 76	2.5	3.0	4.5	3.5
Multigerm LSR/CTR	20011017 - 64	3.0	4.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 20	2.5	3.5	4.5	3.5
Multigerm LSR/CTR	20011017 - 92	2.5	2.5	4.5	3.0
Multigerm LSR/CTR	20011017 - 55	2.5	3.5	4.5	4.0
Multigerm LSR/CTR	20011017 - 93	2.5	3.8	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 24	2.5	2.5	4.5	3.5
Multigerm LSR/CTR	20011017 - 36	2.0	2.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 26	3.0	3.0	4.5	3.5
Multigerm LSR/CTR	20011017 - 60	2.8	3.0	4.5	4.3
(2859 & 2890 X FC604 & FC607)	20011005 - 28	3.0	3.5	4.5	3.8
Multigerm LSR/CTR	20011017 - 45	2.8	3.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 31	3.0	3.5	4.5	3.0
Multigerm LSR/CTR	20011017 - 37	2.5	2.5	4.5	3.0
Multigerm LSR/CTR	20011017 - 67	3.0	3.0	4.5	3.0
Multigerm LSR/CTR	20011017 - 46	2.5	3.5	4.5	3.5
Multigerm LSR/CTR	20011017 - 87	3.0	2.5	4.5	3.5
Multigerm LSR/CTR	20011017 - 91	2.5	3.0	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 38	3.0	3.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 41	3.0	4.0	4.5	4.3
Multigerm LSR/CTR	20011017 - 47	2.5	2.5	4.5	3.5
Multigerm LSR/CTR	20011017 - 44	3.3	3.5	4.5	3.3
(2859 & 2890 X FC604 & FC607)	20011005 - 55	3.0	3.5	4.5	3.0
(2859 & 2890 X FC604 & FC607)	20011005 - 50	3.0	3.0	4.5	4.3
Multigerm LSR/CTR	20011017 - 48	3.0	3.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 54	2.8	3.5	4.5	4.0
Multigerm LSR/CTR	20011017 - 19	2.5	3.5	4.5	4.0
Multigerm LSR/CTR	20011017 - 12	2.0	3.0	4.5	3.5
Multigerm LSR/CTR	20011017 - 61	2.5	3.5	4.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 48	2.8	3.5	4.8	3.5
Multigerm LSR/CTR	20011017 - 81	3.0	3.5	4.8	3.8
Multigerm LSR/CTR	20011017 - 52	3.0	3.5	4.8	3.5
Multigerm LSR/CTR	20011017 - 15	3.0	3.5	4.8	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 14	2.5	3.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 5	3.0	4.0	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 23	2.5	4.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 8	2.5	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 14	2.5	4.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 32	2.5	3.0	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 17	2.8	3.5	5.0	3.3
Multigerm LSR/CTR	20011017 - 22	3.0	3.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 11	3.0	4.0	5.0	4.0

Table 10. Experiment 9A, 2001. Leaf Spot Evaluation of USDA-ARS Fort Collins progeny families.

		Disease Index[1]			
		Sept. 3rd	Sept. 10th	Sept. 17th	Sept. 24th
LSS [2]	**931002**	**3.0**	**4.0**	**5.5**	**4.0**
LSR [3]	**821051H2**	**2.5**	**4.0**	**5.5**	**4.0**
(2859 & 2890 X FC604 & FC607)	20011005 - 30	3.0	4.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 3	2.0	3.0	5.0	5.0
Multigerm LSR/CTR	20011017 - 27	2.5	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 28	3.0	3.5	5.0	4.0
Multigerm LSR/CTR	20011017 - 18	2.5	3.8	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 10	2.5	3.5	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 16	3.0	4.0	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 12	2.5	3.5	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 16	3.3	4.0	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 34	3.0	4.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 38	2.0	3.0	5.0	4.0
Multigerm LSR/CTR	20011017 - 16	2.5	4.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 35	3.0	3.5	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 28	2.0	3.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 40	3.0	4.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 38	3.0	3.5	5.0	4.0
Multigerm LSR/CTR	20011017 - 42	2.5	3.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 49	2.5	3.0	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 18	3.0	4.0	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 52	3.3	3.8	5.0	4.3
(2859 & 2890 X FC604 & FC607)	20011004 - 36	3.0	3.5	5.0	4.0
Multigerm LSR/CTR	20011017 - 20	3.0	3.8	5.0	3.5
(2859 & 2890 X FC604 & FC607)	20011004 - 27	2.5	3.8	5.0	4.0
Multigerm LSR/CTR	20011017 - 83	3.0	3.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 78	2.0	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 75	2.5	3.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 53	3.0	3.5	5.0	4.0
Multigerm LSR/CTR	20011017 - 54	3.0	4.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 73	3.0	4.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 56	2.5	3.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 57	3.0	3.0	5.0	4.0
Multigerm LSR/CTR	20011017 - 58	3.0	3.5	5.0	4.0
Multigerm LSR/CTR	20011017 - 59	2.5	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 88	2.5	3.0	5.0	3.5
Multigerm LSR/CTR	20011017 - 9	2.5	2.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 62	2.5	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 68	3.0	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 65	2.8	3.5	5.0	3.5
Multigerm LSR/CTR	20011017 - 69	2.8	3.8	5.0	3.8
(2859 & 2890 X FC604 & FC607)	20011004 - 31	2.8	3.5	5.0	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 47	2.0	3.0	5.0	3.0
(2859 & 2890 X FC604 & FC607)	20011004 - 21	3.0	3.5	5.3	4.0
Multigerm LSR/CTR	20011017 - 89	2.0	3.5	5.3	3.8

Table 10. Experiment 9A, 2001. Leaf Spot Evaluation of USDA-ARS Fort Collins progeny families.					
		Disease Index[1]			
		Sept. 3rd	Sept. 10th	Sept. 17th	Sept. 24th
LSS [2]	**931002**	**3.0**	**4.0**	**5.5**	**4.0**
LSR [3]	**821051H2**	**2.5**	**4.0**	**5.5**	**4.0**
(2859 & 2890 X FC604 & FC607)	20011005 - 42	3.0	3.3	5.3	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 11	3.0	4.0	5.3	3.8
(2859 & 2890 X FC604 & FC607)	20011004 - 29	2.5	3.5	5.3	4.0
Multigerm LSR/CTR	20011017 - 26	3.0	3.8	5.3	3.8
(2859 & 2890 X FC604 & FC607)	20011005 - 19	3.3	4.0	5.3	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 23	3.5	4.0	5.5	4.0
Multigerm LSR/CTR	20011017 - 30	2.5	4.0	5.5	3.8
Multigerm LSR/CTR	20011017 - 41	2.5	4.0	5.5	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 37	3.3	3.8	5.5	4.0
Multigerm LSR/CTR	20011017 - 80	3.0	4.0	5.5	3.5
(2859 & 2890 X FC604 & FC607)	20011005 - 17	3.0	3.8	5.5	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 25	3.0	4.0	5.5	4.5
Multigerm LSR/CTR	20011017 - 43	3.0	4.0	5.5	4.5
(2859 & 2890 X FC604 & FC607)	20011004 - 39	3.0	4.0	5.5	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 44	2.5	3.5	5.5	4.0
Multigerm LSR/CTR	20011017 - 35	3.0	4.0	5.5	4.5
(2859 & 2890 X FC604 & FC607)	20011005 - 15	3.3	4.0	5.5	4.0
(2859 & 2890 X FC604 & FC607)	20011005 - 21	3.0	4.0	5.5	4.3
(2859 & 2890 X FC604 & FC607)	20011004 - 22	2.5	3.5	5.5	4.0
(2859 & 2890 X FC604 & FC607)	20011004 - 26	3.0	4.0	5.5	4.5
(2859 & 2890 X FC604 & FC607)	20011004 - 25	3.0	4.5	5.5	4.5
Multigerm LSR/CTR	20011017 - 66	3.0	4.5	6.0	4.5
(2859 & 2890 X FC604 & FC607)	20011005 - 33	3.3	4.5	6.0	4.5
(2859 & 2890 X FC604 & FC607)	20011004 - 19	2.5	4.0	6.0	5.0

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 11. Progeny families from the USDA-ARS Fort Collins breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.			
		Disease Index*	
Seed Source	Description	17 Aug	31 Aug
96A008	**Beta G6040**	**4.0**	**4.0**
20011017 -86	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.0	4.0
20011005 -44	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.3	4.3
20011005 -33	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.5	4.5
20011004 -15	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.5	4.5
20011005 -19	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	4.7
20011005 -30	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	4.7
96A008	**Beta G6040**	**4.7**	**4.7**
20011004 -18	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.3	4.7
20011005 -34	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.3	4.7

Table 11. Progeny families from the USDA-ARS Fort Collins breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.			
		Disease Index*	
Seed Source	Description	17 Aug	31 Aug
20011004 - 20	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011004 - 13	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.0	5.0
20011004 - 22	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011004 - 11	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.0
20011004 - 21	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.3	5.0
20011004 - 8	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011005 - 23	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011017 - 73	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.0	5.0
20011005 - 54	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011005 - 41	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011005 - 17	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011005 - 24	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011004 - 31	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	5.0
20011005 - 28	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	5.0
20011005 - 20	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011005 - 32	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.0
20011005 - 42	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.3
20011004 - 32	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.3
20011004 - 24	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	5.3
20011005 - 48	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.3
20011005 - 31	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.3
20011004 - 16	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.3
20011004 - 28	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.3
20011017 - 72	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	5.3
20011017 - 26	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.0	5.3
20011004 - 17	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.3
20011004 - 51	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.3
20011005 - 47	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.3
20011005 - 9	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.3
20011005 - 10	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.3
20011004 - 49	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.5	5.5
20011004 - 41	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.5
20011005 - 15	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.5	5.5
20011005 - 11	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.5
20011017 - 8	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.0	5.5
20011017 - 91	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.0	5.5
20011017 - 87	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.0	5.5
20011017 - 71	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	5.5
20011005 - 55	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.5	5.5
20011005 - 22	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7
20011005 - 21	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	5.7
20011004 - 50	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	5.7
20011005 - 13	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	5.7
20011005 - 37	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7
20011005 - 26	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.7
20011005 - 27	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	4.7	5.7
20011004 - 40	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7
20011017 - 84	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	5.7
20011004 - 38	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7

Table 11. Progeny families from the USDA-ARS Fort Collins breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.

Seed Source	Description	Disease Index* 17 Aug	Disease Index* 31 Aug
20011005 -50	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.7
20011004 -35	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.7
20011005 -51	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	5.7
20011005 -36	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.7
20011017 -41	4918, FC902, 278, FC607., MonoHy-T6, -A7, -A4, & SR87	5.7	5.7
20011005 -38	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.7
20011017 -83	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	5.7
20011017 -77	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	5.7
20011017 -76	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	5.7
20011017 -59	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	5.7
20011004 -12	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7
20011004 -25	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7
20011005 -52	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	5.7
20011004 -19	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	5.7
20011017 -48	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	5.7
20011017 -68	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	5.7
20011004 -52	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	6.0
20011004 -34	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.5	6.0
20011004 -36	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	6.0
20011004 -26	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	6.0
20011004 -29	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	6.0
20011005 -25	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.5	6.0
20011017 -38	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	6.0
20011017 -50	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.0
20011017 -51	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	6.0
20011017 -19	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.0
20011017 -80	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	6.0
20011017 -75	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	6.0
20011017 -79	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	6.0
20011017 -24	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.0
20011004 -23	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	6.0
20011017 -27	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.0
20011017 -74	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.0
20011017 -92	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	6.0
20011017 -30	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.0
20011004 -6	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.0	6.0
20011004 -5	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	6.0	6.0
20011017 -69	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	6.0
20011017 -90	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	6.0
20011017 -82	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.3	6.0
20011005 -16	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	6.0
20011017 -43	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	6.0
20011017 -81	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.3
20011017 -15	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.3
20011017 -60	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.3
20011017 -67	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	6.3
20011017 -66	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.3
20011017 -9	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.3
20011017 -29	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	6.5

Table 11. Progeny families from the USDA-ARS Fort Collins breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.			
		Disease Index*	
Seed Source	Description	17 Aug	31 Aug
20011017 -93	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.5
20011017 -36	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	6.5
20011017 -52	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	6.5
20011004 -33	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	6.0	6.5
20011005 - 14	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	6.5	6.5
20011017 -88	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	6.5
20011017 -53	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011005 - 18	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	6.0	6.7
20011017 -45	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	6.7
20011017 -65	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011017 -39	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011004 -30	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.3	6.7
20011017 -44	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011017 -42	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011017 -61	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	6.7
20011017 - 12	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011004 -39	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	5.7	6.7
20011017 -78	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.7
20011017 - 18	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011017 -22	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.7
20011004 -27	[2859aa x (FC607 & FC604)] + [2890aa x (FC607 & FC604)	6.3	6.7
20011017 -35	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	6.7
20011017 -31	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	6.7
20011017 -40	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	7.0
20011017 -32	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	7.0
20011017 -37	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	7.0
20011017 -20	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.7	7.0
20011017 -33	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.5	7.0
20011017 -28	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.5	7.0
20011017 -56	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	7.0
20011017 -54	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.5	7.0
911032	**Susceptible Check – FC718**	**6.3**	**7.0**
20011017 - 16	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	7.0
20011017 -58	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	7.0
20011017 -47	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.3	7.3
20011017 -57	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.0	7.5
20011017 - 1	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	5.5	7.5
20011017 -63	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.3	7.7
20011017 -64	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.0	7.7
20011017 -55	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.0	7.7
20011017 - 17	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.0	8.0
911032	**Susceptible Check – FC718**	**7.7**	**8.0**
20011017 -62	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.7	8.0
20011017 -89	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	8.0
20011017 -46	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	7.0	8.0
20011017 - 14	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.7	8.3
20011017 -23	4918, FC902, 278, FC607, MonoHy-T6, -A7, -A4, & SR87	6.0	9.0

*Disease Index (DI) scale = 0 (no symptoms) to 9 (plant death).

Table 12. Advanced smooth root germplasm from the USDA-ARS East Lansing breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.

		Disease Index*	
Identification	Donor's ID	17 Aug	31 Aug
2001A013	EL0204	6.7	7.0
2001A014	SR96 (95HS6)	7.0	7.7
2001A015	SR95	7.0	7.0
2001A016	SR94	6.7	7.0
2001A017	SR93	7.7	7.7
2001A018	SR80	7.0	8.0
2001A019	SR87	7.3	8.0
2001A020	94HS25	6.7	7.0
2001A021	99J19-00mm	7.0	8.0
2001A022	98J26-052 mm	7.5	7.5
2001A023	99J31-00 mm	6.0	7.0
911032	**FC718 - Susceptible Check**	7.5	8.0
96A008	**Beta G6040 - Resistant Check**	5.0	5.0

*Disease Index (DI) scale = 0 (no symptoms) to 9 (plant death).

Table 13. Advanced and experimental germplasm from the USDA-ARS Fort Collins breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.

			Disease Index*	
Entry	Identification	Donor's ID	17 Aug	31 Aug
224	**96A008**	**Beta G6040 - Resistant Check**	**5.0**	**4.7**
225	**911032**	**FC718 - Susceptible Check**	**7.3**	**7.3**
198	911043HO1	FC403CMS	5.7	5.3
193	20011016	Rhx=zcRmm (991001) {2859 & 2890 X FC708	6.0	5.7
222	911043HO1	FC403CMS	6.0	6.0
170	951016HO	FC723 – EL44/FC708 mm	5.7	6.0
181	991003H	FC607 & FC604 with 2890, 2859 (Salinas)	6.0	6.0
200	911043HO	FC403	5.3	6.0
177	981011H	(2859 & 2890 X FC607 & FC604) CTR	5.7	6.0
187	20001008	(FC907 X FC709-2)-sel single family	5.7	6.0
184	20001004	LSR/CTR MM X LSR Fargo (981036)	6.3	6.3
220	931005HO	FC721	6.0	6.3
179	981032	Sucrose MMaa X LSR PI540596 - biennial maritima LSR	5.7	6.3
219	20011016		5.5	6.5
176	981010H	(2859 & 2890 X FC607 & FC604) LSR	6.3	7.0
182	991026MS	Sucrose MMaa population X PI535826 (Giant Poly - LSR)	6.5	7.0
221	931005HO1	FC721CMS	6.3	7.0
185	20001006	LSR(4x) X Sucrose(4x)	5.7	7.0
175	971020	FC901-1 – FC607/FC701 BC4	6.3	7.0
186	20001007	LSR MM with Fargo	7.3	7.0
218	20011013H	(FC907 X FC709-2)-RhzcR sel-hs-blk	6.3	7.0
189	20001016H02	(FC708CMS X FC709-2)	6.7	7.0

Table 13. Advanced and experimental germplasm from the USDA-ARS Fort Collins breeding program tested in the BSDF Curly Top Nursery in Kimberly, ID in 2001.

			Disease Index*	
Entry	Identification	Donor's ID	17 Aug	31 Aug
224	**96A008**	**Beta G6040 - Resistant Check**	**5.0**	**4.7**
225	**911032**	**FC718 - Susceptible Check**	**7.3**	**7.3**
215	2001A010	R6 – doubled haploid	6.7	7.0
206	97A050	FC607	6.3	7.0
204	921022	FC702-7	7.3	7.0
172	961010HO	FC722-1 – C718/FC708	5.0	7.0
171	951016HO1	FC723 CMS – EL44/FC708 CMS	5.7	7.0
183	991026PF	Sucrose MMaa population X PI535826 (Giant Poly - LSR)	6.7	7.3
194	981037		7.3	7.3
195	991016	FC702-2	7.0	7.3
205	921025	FC728	6.7	7.3
214	2001A009	R5 – doubled haploid	7.3	7.3
202	911026HO	FC715	6.3	7.3
223	991015	FC801	6.5	7.5
203	921021	FC703-5	7.0	7.5
190	20011001	LSR Polycross with East Lansing material	7.0	7.5
217	991011	FC709-2 selected in Kiel	6.5	7.5
199	951016HO	FC723	6.3	7.7
207	981025	FC717	6.3	7.7
208	001016H	FC709-2	7.0	7.7
196	991018	FC709	7.0	7.7
192	20011003HO1	FC712/MonoHy A4 - CMS equivalent	7.3	7.7
211	2001A006	R2 – doubled haploid	7.3	7.7
197	991019	FC711	7.0	7.7
188	20001009	(FC907 X FC709-2)-sel multiple families	7.0	7.7
180	981033PF	Sucrose MMaa X LSR PI540599 - annual maritima LSR	6.5	8.0
209	951017	FC727	7.7	8.0
173	961010HO1	FC722 CMS – C718/FC708 CMS	6.3	8.0
210	2001A005	R1 – doubled haploid	8.0	8.3
212	2001A007	R3 – doubled haploid	8.3	8.3
174	961013HO	FC506	7.7	8.3
201	831085HO	FC708	7.5	8.5
191	20011003HO	FC712/MonoHy A4	7.3	8.7
213	2001A008	R4 – doubled haploid	8.0	8.7
216	2001A011	R7 – doubled haploid	6.0	9.0
178	981012	(2859 & 2890 X FC607 & FC604) CTR	9.0	9.0

*Disease Index (DI) scale = 0 (no symptoms) to 9 (plant death).

Pre-breeding: the Introgression of New Sources of Cercospora Leaf Spot Resistance from *Beta Vulgaris* ssp. *maritima* and Other Exotic Sources into Sugar Beet-type Populations. – BSDF Project 443

Lee Panella
Fort Collins, Colorado

A major emphasis of the research mission of the USDA-ARS plant scientists is the collection, documentation, characterization, evaluation, regeneration (maintenance), distribution, and utilization of plant germplasm, especially Plant Introduction (PI) accessions in the USDA-ARS National Plant Germplasm System (NPGS). The Sugar Beet Research Unit at Fort Collins is coordinating the national program for *Beta* germplasm evaluation. In addition to the evaluation for Rhizoctonia and Cercospora resistance, it is crucial that the ARS scientist be involved in the long rang, high risk research problems involved in sugar beet 'germplasm enhancement' or 'pre-breeding' from exotic germplasm or wild relatives. This is an important component in the overall sugar beet improvement effort of the Fort Collins Sugar Beet Research Unit.

Justification for Research:

Cercospora leaf spot (caused by the fungus *Cercospora beticola* Sacc.) is one of the most widespread diseases of sugar beet and is a serious problem in many sugar beet production areas throughout the U.S. The disease damages the leaves, which, consequently, reduces root yield, percent sucrose of roots, and purity of the extracted juice. Cercospora leaf spot currently is controlled by combining spraying with commercial fungicides and the use of disease tolerant germplasm. The development of Cercospora leaf spot resistant sugar beet lines and hybrids with greater levels of host-plant resistance offers a more sustainable solution to this disease problem.

If the level of resistance available in some Cercospora-resistant experimental breeding lines were present in commercial hybrids (**along with good sugar and seed yield**), the need for fungicides could be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed is evident by the occurrence of *Cercospora* strains that are tolerant to our most potent fungicides. Additionally, some fungicides may be removed from the market because of their perceived or real threat to the environment.

Finally, the genepool for resistance to Cercospora leaf spot is extremely narrow. Many of the resistant lines are highly inbred, therefore, closely related to one another, and stem from germplasm coming out of Italy in the early 1900s. In the germplasm developed at Fort Collins, continued inbreeding has increased the level of disease resistance, but at the cost of plant vigor. Over the long term, a secure, sustainable response to this disease requires commercial quality hybrids with good host-plant resistance.

Objectives:

1. The formation of long range breeding populations through the introgression of Cercospora resistant germplasm from "exotic" sources (*Beta vulgaris* spp. *maritima*, fodder beet, foreign sugar beet landraces from the PI collection, etc.).

2. The development of germplasm populations from these long range populations that are of sufficient agronomic quality to be of use to commercial breeders. They will be a source of

leaf spot resistance with and within differing genetic backgrounds.

3. The development of techniques (both traditional and molecular) to more efficiently introgress the exotic germplasm into sugar beet breeding populations.

Research Progress 2001:

We have increased or made crosses in eighteen populations listed below (See table 14 below). All of the male parents are germplasm that have been identified as having resistance to *Cercospora beticola* (causal agent of Cercospora leaf spot). The families from various crosses are in different stages of development and evaluation. At the F_3 stage, when sufficient seed is available, we are beginning field screening and selection. Seed of these families has been bulk increased and is beginning to be evaluated. All show some annual plants in our environment.

We are re-crossing some of those from which we obtained insufficient F_1 seed. Plants from those populations producing some biennial plants are being vernalized for 90 days and the populations are being increased (i.e., random mated using the genetic male sterility where possible). The annuals will be handled in a similar fashion once the F_1 populations have been increased. All will be cycled through at least three cycles of random mating.

The most advanced populations were screened for resistance to Cercospora leaf spot and curly top (Experiment 7A, 2001 – Table 9 and 13). Leaf spot evaluations showed good levels of resistance for some of the populations and some also showed resistance to the curly top virus. All of the populations are still segregating for biennial growth habit, easy bolting, and other wild traits.

Table 14. List of germplasm used in developing Cercospora leaf spot resistant populations and the stage of each of the populations. Those populations in bold print have been increased in 2001 or are in the process of being increased in 2001.

Accession Number (♂)	♀ parent	Donor (♂) Designation	Name or Origin (♂)	% Bolting (♂) without induction 1996 Fort Collins	F_1 Population	F_2 Population	F_3 Population	F_4 Population
96A010	961005	PI 535826	Giant Poly	20%	971021H2	981031	991026	**20011027**
96A011	961005 19991024H2	PI 535833	Saturn	0%	--- **2001043H2**			
96A014	961005	PI 540593	WB 847	0%	971023H2	**20021026**		
96A015	961005	PI 540596	WB 850	70%	971024H2	981032	**20011002**	
96A017	961005	PI 540605	WB 859	25%	971025H2	**20011054**		
96A012	961005	PI 535843	PN MONO 1	100%	971026H2[1]			
96A013	961005	PI 540575	WB 829	100%	971027H2[2]			
96A016	961005	PI 540599	WB 853	50%	971028H2	981033	**20011045**	
94A079	961005	BGRC #32375 (*B. v.* ssp. *maritima*)	Greece	annual	971029H2	**20011036**		
94A080	961005	BGRC #36538 (*B. v.* ssp. *maritima*)	Greece	annual	971030H2[3]	**20011037**		
94A081	851046HO	BGRC #45511 (*B. v.* ssp. *maritima*)	Greece	annual	981001H3	**20011038**		
94A081 981001H	961005 19991024H2	BGRC #45511 (*B. v.* ssp. *maritima*)	Greece	annual	--- **20011046H2**			
94A082	851046HO	*BGRC* #45516 (*B. v.* ssp. *maritima*)	Greece	annual	981002H3	**20011039**		
94A082 981002H	961005 19991024H2	*BGRC* #45516 (*B. v.* ssp. *maritima*)	Greece	annual	--- **2002????H2**			

Table 14. List of germplasm used in developing Cercospora leaf spot resistant populations and the stage of each of the populations. Those populations in bold print have been increased in 2001 or are in the process of being increased in 2001.

Accession Number (♂)	♀ parent	Donor (♂) Designation	Name or Origin (♂)	% Bolting (♂) without induction 1996 Fort Collins	F_1 Population	F_2 Population	F_3 Population	F_4 Population
94A083	961005	BGRC #48810 (*B. v.* ssp. *maritima*)	Tunisia	annual	981003H2	**20011040**		
94A083	851046HO	BGRC #48810 (*B. v.* ssp. *maritima*)	Tunisia	annual	981003H3	**200110141B** **200110141bb**		
94A084	961005	BGRC #48819 (*B. v.* ssp. *maritima*)	Tunisia	annual	981004H2	**20011042**		
94A084 981004H	961005 19991024H2	BGRC #48819 (*B. v.* ssp. *maritima*)	Tunisia	annual	--- **2002????H2**			
94A085 981005H	961005 19991024H2	BGRC #51430 (*B. v.* ssp. *maritima*)	Greece	annual	--- **2002????H2**			

[1]Only 16 seed balls produced.
[2]Only 10 seed balls produced.
[3]Only 60 seed balls produced.

Materials and Methods:

Artificial field inoculation with *Cercospora beticola* and leaf spot scoring will be used to identify the resistant germplasm sources and make selections in the developing populations. The exotic materials will be crossed into sugar beet populations that have been selected for agronomic quality (recoverable sucrose yield). These sucrose populations are based on old commercial varieties (i.e., MonoHy T6, A7, A4), donated breeding lines from American Crystal Sugar Co. and Seedex, Inc., and USDA-ARS developed germplasm such as L-19 (WC9127OM) and East Lansing smooth root germplasm, SR87. Other parents include high sucrose germplasm from Poland and other Eastern European countries. Salinas parent '3859' was used to produce populations that are self-fertile (S^f) and segregating for nuclear male sterility (*A-:aa*).

Hybrid populations will be handled in the following manner: 1) Following the initial cross, a population will be random mated (using *aa* females because of the self-fertility) for three to four generations to break up linkage groups and remove annual plants. 2) Sugar beet-type mother roots will be selected, selfed, and progeny tested for agronomic performance and disease resistance. 3) Selected roots will be recombined (and backcrossed if desirable) and re-selected until they ready for release. Molecular markers (RFLPs, RAPDs, SSRs, AFLPs, etc.) as they become available will be used to expedite the backcrossing program and to follow the change in allele frequencies in the selected populations. Advanced populations will be released to the sugar beet seed industry.

Summary of Literature:

Cercospora leaf spot has been an intermittent problem in sugar beet growing areas of the United States where the summers can be hot and humid (Red River Valley, Michigan, Ohio, and, less often, Great Plains growing areas and California). It has been estimated that a severe epidemic can cause up to a 42% loss of gross sugar (Smith and Martin, 1978; Smith and Ruppel, 1973), or up to a 43% relative dollar loss (Shane and Teng, 1992).

Resistance to Cercospora leaf spot has long been a goal of the USDA-ARS sugar beet research program at Fort Collins and researchers there developed the techniques necessary to manage the screening nurseries in such a way as to promote the development of the disease (Ruppel and Gaskill, 1971). A careful crop rotation (sugar beet-barley-barley-barley-sugar beet) and the arid climate and low relative humidity have allowed this to be done in such a manner that there are rarely high enough levels of any other disease present in the leaf spot nursery to confound the results.

There are an estimated 4 or 5 genes responsible for *Cercospora* resistance (Smith and Gaskill, 1970) and broad-sense heritability estimates ranged from 12 to 71% (Bilgen et al., 1969). Narrow-sense heritability estimates of about 24% compared well with realized heritability values, and 44 to 62% of the variation was due environment in this test (Smith and Ruppel, 1974). The large environmental variation has made it difficult to make progress in developing *Cercospora* resistance through mass selection. Incorporation of high levels of leaf spot resistance into varieties with superior agronomic performance also is difficult (Smith and Campbell, 1996) and, therefore, commercial resistant varieties require some fungicide application to provide adequate levels of protection against Cercospora (Miller et al., 1994).

A major problem in the development of *Cercospora*-resistant sugar beet is the loss of vigor due to the continual inbreeding. Coons (1955) noted this and it has been a concern ever since (McFarlane, 1971). The use of hybrid varieties has ameliorated this problem to some extent, but seed production on the highly inbred O-type males and CMS females still is a problem. This is seen in germplasm from both the FC 500 and FC 600 series developed at Fort Collins.

The USDA-ARS National Plant Germplasm System *Beta* collection has over 2,000 Plant Introduction (PI) accessions. The germplasm used most often in sugar beet breeding is from *Beta vulgaris* spp. *vulgaris*, which includes all of the biennial sugar beet types, or from *Beta vulgaris* spp. *maritima*, which contains the closely related wild sea beet and has both annual and biennial types. Germplasm with a biennial flowering habit is easier both to introgress and screen. *Beta vulgaris* spp. *maritima* has, nonetheless, been used as a source of resistant germplasm. Much of the *Cercospora*-resistant germplasm in use today came out of Munerati's program in Italy, in which *B. vulgaris* spp. *maritima* was the source of resistance genes (Lewellen, 1992). There have been very few new efforts to locate and incorporate other sources of resistance to *Cercospora* into this narrow germplasm base.

There is an urgent need to continue to create in our *Cercospora*-resistant germplasm a broader genetic base than we have today. As commercial hybrid parents become more inbred, the germplasm base from which these inbred parents are developed must have the diversity necessary to provide for maximum gain through heterosis. Munerati's success, and the research of others, has shown that it can be done if we have the persistence to do it (Bilgen et al., 1969; Doney, 1993; Lewellen, 1995).

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Development And Testing of Sugar Beet Cyst Nematode Resistant Germplasm (BSDF Project 446)

Lee Panella, Saad Hafez and Bob Lewellen
Fort Collins, CO; Parma, ID; and Salinas, CA

Justification for Research:

The sugar beet cyst nematode (SBCN) (*Heterodera schachtii*, Schmidt) is one of the most serious pests of sugar beet (*Beta vulgaris* L. subsp. *vulgaris*) throughout the western United States and many other parts of the world where sugar beet is cultivated. Nematode infested fields will first look wilted and as the stress grows, the sugar beet plants are underdeveloped and chlorotic. The root tip is destroyed and the main tap root deformed. Secondary roots proliferate from the tap root in the upper soil profile giving the root a beard-like appearance (sometimes confused with Rhizomania) and diminishing the ability of the plant to absorb water from deeper in the soil profile. The yellow and brown females (cysts) can be found on these secondary roots.

The damage is caused by the nematode destroying the tap root, diminishing the ability of the plant to absorb water, and feeding on the plant cytoplasm in the infested root cells. In heavily infested fields, crop yields can be depressed by up to 80%. Current management systems rely on Telone II™, Temik™, or other nematicides. These nematicides/fumigants have been removed from the market in some states and are in danger of being removed in others because of their perceived or real threat to the environment.

There have been no SBCN resistant varieties released in the U.S. market. Most SBCN resistant commercial varieties or those near commercialization rely on the resistance transferred from the section Procumbentes species. The introgression of this resistance gene was through a translocation that happened in a monosomic addition line. There is still a linkage drag associated with these lines that keep there yield between 10 and 15% less than high performing commercial lines.

Screening of the USDA-ARS National Plant Germplasm System's (NPGS) *Beta* collection in 1998 and 1999 for resistance to SBCN showed 5 potential accessions with varied degrees of resistance to SBCN. On a 0 to 9 scale (with 0 being immune), one accession was rated as 3 and four accessions were rated as 4 (See Appendices 1 & 2). The experimental design was randomized block with five replications and there were differences among the plants making up the replications. Again in this year's Sugar Beet CGC coordinated evaluations, two accessions were rated as 2 and two accessions were rated as 4.

Research Progress 2001

Four sugar beet accessions, which had shown some promise of SBCN resistance, were sent to Dr. Hafez (U of I, Parma, ID) for evaluation. Fifty plants each of PI 142808, PI 142809, PI 232894, and PI 357354 were planted for evaluation (Appendix 1). Germination was poor in PI 142808 and it was replanted. The most resistant plants from these four varieties were transplanted after testing in Idaho, and the resulting stecklings were sent to the USDA-ARS Crops Research Laboratory in Fort Collins, Colorado. This first set of nematode resistance donor parents is biennial and the stecklings were vernalized (induced by a 3 month period of cold temperature to flower) this past spring. This summer and fall, they were crossed in the greenhouse for hybrid seed (F_1) production. They were crossed to Rhizomania resistant, male sterile (*aa*), self-fertile female lines, 9933 and 0931 (provided by R. T. Lewellen/USDA-ARS Salinas, California). Individual plant

crosses, as well as polycrosses (among multiple plants), were made within all four populations. The polycrosses will be bulked within each accession and kept isolated from the others. The controlled pair crossing will be used for genetic analyses, in addition to the furthering the breeding program. Currently most all of the seed has been harvested and threshed, and there is about 160 grams of bulk increased and hybrid seed (Table 15). All of the threshing was finished by the end of January of 2002.

Table 15 - 2001 Seed Production

Variety*	Code #	Pl. No.	Notes	Amount Seed (g)
931	200		2nd f. with 515	7.18
931	202		many V1 cross	0.80
9933	204		renum; many V2 cross	0.35
931	210		2nd fem, cr. W 339	0.38
9933	214		renum; cr w 486 (1 pot)	1.02
9933	216		2ndw 497 but is male	0.19
V3	320	26	Old, many V3 cross	0.10
V3	333	49	Old many V3 cross	0.47
V4	336	7	Old, many V4 cross	13 sb
V4	339	19	Old, thn xw873&210	0.02
V4	345	46	Old many V4 cross	0.12
V4	346	48	Old	0.40
9933	348	2	female,cross with 559	0.39
9933	353	7	female, Cross with 534	0.78
9933	357	11	female, cross with 525	1.20
9933	358	12	female, cross with 525	1.46
9933	368	22	female, cross with 535	1.08
9933	370	24	female, cross with 563	1.79
9933	371	25	female,cross with 540	0.63
V1	381	1	New Many V1 cross	2.33
V1	382	2	New many V1 cross	6.46
V1	384	5	New Many V1 cross	0.93
V1	385	14	New Many V1 cross	5.04
V1	397	7	New ?many V1?	3.41
V1	403	13	New cross w 705 & 897	3.46
V1	404	15	New Many V1 cross	7.88
V1	407	18	Many V1 cross	3.73
V1	415	29	New many V1 cross	5.30
V2	461	33	Newmany V2 cross	0.15
V3	475	1	New c w 686	0.04
V3	476	3	New cr with 676,**male**	2.63
V3	479	6	New	2.30
V3	480	7	New many V3 cross	1.25
V3	482	9	New many V3 cross	2.54
V3	483	10	New many V3 cross	3.94
V3	485	12	New cr with 718	0.17
V3	486	13	New, cr with 214&216	0.30
V3	487	14	New many V3 cross	5.47
V3	488	15	New many V3 cross	2.16
V3	489	16	New xw 724 & 782, ck 788	0.11
V3	493	20	New many V3 cross	3.74

Table 15 - 2001 Seed Production				
				Amount
Variety*	Code #	Pl. No.	Notes	Seed (g)
V3	496	23	New cr. 729&704&726	1.04
V3	497	24	c w 739& but male 216late	0.58
V3	498	25	New many V3 cross	2.38
V3	499	26	New many v3 cross	1.76
V3	501	28	New cr with 667, 770	0.38
V3	504	31	New many v3 cross	2.57
V3	505	33	New many V3 cross	2.99
V3	510	39	New	2.63
V3	513	42	New; cr. W 744 & 781	0.37
V3	515	44	New cr. w 778 & 202	0.57
V4	524	5	New, many V4 cross	0.36
V4	525	6	New, cross w 11&12	1.96
V4	526	7	New, many V4 cross	0.71
V4	527	8	New, cross with 587	0.63
V4	530	11	New, cross with 581	0.95
V4	534	16	New, cross with 7	0.06
V4	535	17	New, cross with 22	0.44
V4	536	18	New many V4 cross	0.41
V4	537	19	New, cross with 585	0.34
V4	538	20	New, many V4 cross	0.98
V4	543	25	New, cross with 578	0.34
V4	545	28	New, cross with 575	0.06
V4	546	29	New cross with 573	0.43
V4	557	41	New cross with 583	1.61
V4	558	42	New cross with 580	0.45
V4	560	44	New cross with 577	0.21
V2	571	33	Old many V2 cross	0.02
9933	572	female	cross with 544	0.40
9933	573	female	cross with 546	0.51
9933	574	female	cross with 551, which died	1.66
9933	575	female	cross with 545	1.99
9933	576	female	cross with V4 males	0.75
9933	578	female	cross with 543	2.04
9933	580	female	cross with 558	0.07
9933	581	female	cross with 530	0.85
9933	583	female	cross with 557	0.73
9933	587	female	cross with 527	4.23
9933	590	female	cross with V4 males	0.06
9933	592	female	cross with V4 males	5.81
931	597		died	1.68
931	601		one of 2 fem. With 430	0.45
931	602		many V4 cross	0.07
931	606		cross with 408	0.02
9933	608	female	cross with V4 males	1.84
9933	613		Many V3 cross	0.67
9933	619		Many V2 cross	0.07
9933	623	unknown	?	0.32
9933	627		many V4 cross	0.26
9933	633		many V1 cross	0,49

Table 15 - 2001 Seed Production				
				Amount
Variety*	Code #	Pl. No.	Notes	Seed (g)
9933	637		male	0.71
931	643		many V4 cross	0.07
931	651		many V4 cross	5.31
931	654		many V1 cross	0.26
931	656		many V4 cross	0.05
931	661		cross with 434	0.37
9933	667		renum; cr w 501	20sb
9933	669		renum; many V3 cross	0.57
931	681		many V1 cross	0.37
931	683		many V4 cross	1.67
931	685		many V3 cross	2.08
931	692		many V4 cross	0.41
931	694		many V3 cross	0.02
931	696		Many V1 cross	0.02
9933	704		no documentation	0.48
931	705		2nd fem with 403	0.07
931	706		Many V3 cross	0.87
931	709		many V1 cross	0.10
931	711		cross W 418, 1 of 3	2.22
9933	715		renum; many V3 cross	0.01
9933	724		renum; cr. With 489	0.47
9933	726		renum; 3rd f w 496	0.06
931	727		many V1 cross	0.50
9933	729		renum; cr. W 496	0.34
9933	731		renum; many V3 cr	0.12
9933	744		renum; cr. W 513	0.35
9933	745		renum; many V2 cross	4sb
9933	747		renum; many V3 cross	0.12
931	750		many V1 cross	1.00
9933	752		many V3 cross	0.23
9933	757		renum; c w 518, 2nd fe	0.28
9933	758		renum; many V3 cross	1.22
931	762		Many V2 cross	0.10
9933	767		renum; many V3 cross	1.21
9933	770		renum; 2nd f with 501	0.04
9933	771		renum, many V1 cross	0.49
931	774		cross w 418, 1 of 3	0.56
931	775		cr. W 403, dying	0.15
9933	778		renum, cr. W 515	0.44
931	780		cross with 413	1.14
9933	782		renum; cr w 489,2ndf	0.01
931	790		unknown cross?	0.67
9933	799		renum; many V1 cross	0.14
1039	815		23-Jul-01	0.37
9933	864		8/23/01	0.16
9933	868		9/13/01	0.62
9933	873		1st fem, cr w 339	0.18
9933	878		many V3 cross	1.67

Table 15 - 2001 Seed Production				
				Amount
Variety*	Code #	PI. No.	Notes	Seed (g)
9933	881		8/23/01	0.47
9933	890		many V3 cross	0.57
9933	897		cr with 403	1.05
9933	618B		Many V3 cross	0.32
V1 = PI 142808; V2 = PI 142809; V3 = PI 232894; V4 = PI 357354; 931= 0931(Salinas Rhizomania resistant germplasm); 9933 = (Salinas Rhizomania resistant germplasm				

Summary of Literature Review:

The sugar beet cyst nematode (SBCN) (*Heterodera schachtii*, Schmidt) is one of the most serious pests of sugar beet (*Beta vulgaris* L. subsp. *vulgaris*). It was identified in Germany in the mid 1800s and observed in the US by 1895. It has been reported to be in 17 states throughout the United States (Hafez, 1998, 1999) and in 39 countries where sugar beet is cultivated (Gray et al., 1992). In these areas 10 - 25% of the acreage is infested (Lange and De Bock, 1994). This pest is hosted by over 80% of the species in the *Chenopodiaceae* and *Brassicaceae* families (Steele, 1965; Hafez and Sundararaj, 1998, 1999). Accessions from all four sections of the genus *Beta* have been screened for host plant resistance. No good source of host plant resistance has been found in *Beta vulgaris* subsp. *vulgaris*. All of the species in *Beta* section Procumbentes have shown immunity to the SBCN and there has been a great effort to transfer this immunity to sugar beet (reviewed by Van Geyt et al. (1990)). Because of problems with transmission of the introgressed genes and linked deleterious genes, more molecular approaches have been tried, culminating with the cloning of the $Hs1^{pro\text{-}1}$ gene (Cai et al., 1997). Finally, although there are commercial varieties with the *Procumbentes* source of resistance close to market, there is a concern that the resistance will not be durable. That this resistance can be overcome or at least weakened has been experimentally shown (Lange et al., 1993), and there is concern that this will also be the case when varieties carrying this resistance are widely deployed in the field.

A second source of resistance has been reported from *Beta vulgaris* subsp. *maritima*, which was collected in France. Heijbroek (1977) reported that this material was partially resistant and that the resistance was most probably recessive. This material was transferred to the Foundation for Agricultural Plant Breeding in Wageningen, the Netherlands put into a breeding program. Lange and De Bock (1994) reported that the host plant resistance seen in this sugar beet population was a type of reduced susceptibility that reduced the number and size of cysts produced on its roots. The recessive, polygenic control of this host plant resistance has made plant breeders reluctant to use it in commercial breeding programs.

The USDA-ARS National Plant Germplasm System *Beta* collection has over 2,000 Plant Introduction (PI) accessions. The Sugar Beet Crop Germplasm Committee has had an aggressive evaluation program in place since 1985 (Panella et al., 1998). The germplasm used most often in sugar beet breeding is from *Beta vulgaris* spp. *vulgaris*, which includes all of the biennial sugar beet types, and this material has had the first priority in screening. *Beta vulgaris* spp. *maritima*, which contains the closely related wild sea beet and has both annual and biennial types currently is being screened, and a few potentially SBCN resistant accessions have been identified by Dr. Saad Hafez. Germplasm with a biennial flowering habit is easier to introgress but annual *Beta vulgaris* spp. *maritima*, nonetheless, has been used as a source of resistant germplasm in other resistance breeding

programs, and the research of others has shown that it can be done if we have the persistence to do it (Bilgen et al., 1969; Doney, 1993; Lewellen, 1995).

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Objectives:

1. The formation of long range breeding populations through the introgression of Sugar Beet Cyst Nematode resistant germplasm from "exotic" sources (*Beta vulgaris* spp. *maritima*, fodder beet, foreign sugar beet landraces from the PI collection, etc.).

2. The development of germplasm populations from these long range populations that are of sufficient agronomic quality to be of use to commercial breeders. They will be from differing sources of SBCN resistance with different genetic backgrounds – a present it is impossible to tell whether or not the genes responsible for the resistance are different in the different sources.

3. The development of techniques (both traditional and molecular) to more efficiently introgress the exotic germplasm into sugar beet breeding populations.

Materials and Methods:

Sugar beet seeds have been planted in the greenhouse in conetainers® containing naturally infested beet cyst nematode soil (5.3 eggs and larvae per 1 cm^3 soil). The accessions were compared to the susceptible check, HM WSPM9 and a resistant *B. v.* subsp. *maritima* check. Sugar beet seedlings were separated from soil eight weeks after planting. Mature SBCN females and cysts were counted from the roots and soil. Seven accessions were chosen on the base of their resistance (scored 0 through 9 with 0 most resistant) and taxonomic and geographic differences. Fifty seedlings of each accession were screened and the best performing plants used as SBCN-resistant parents. The screening was done in Parma, ID by Dr. Saad Hafez who has worked with the Sugar Beet CGC to screen the USDA-ARS NPGS's *Beta* collection.

The most resistant parents were sent to Fort Collins, where the crossing and seed production is being done. Appropriate vernalization will be performed on the biennial accessions. Both biennial and annual donor parents will be crossed to a Rhizomania resistant, male sterile (*aa*), self-fertile female line (provided by R. T. Lewellen). A branch of each donor plant will be selfed to determine if the plants are self-incompatible. The crosses will be in bulk with each accession kept isolated from the others. Some controlled pair crossing will be done to provide material for genetic analyses.

Some of the F_1 hybrids will be screened in the Greenhouse for SBCN resistance and they will be bulk increased to provide F_2 plants for evaluation. Populations will be random mated (using *aa* females because of the self-fertility) to break up linkage groups and remove annual plants while being evaluated and selected. Selected roots will be recombined (and backcrossed if desirable) and re-selected until they ready for release. Molecular markers (RFLPs, RAPDs, SSRs, AFLPs, etc.) as they become available will be used when possible to expedite the backcrossing program and to follow the change in allele frequencies in the selected populations. Advanced populations will be released to the sugar beet seed industry.

Appendix 1

1998 CGC Evaluations of NPGS PIs for Resistance to Sugar Beet Cyst Nematode

S. Hafez, M. Larkin, R. Portenier and K. Hara, University of Idaho, Parma, ID 83660

Thirty sugar beet (*Beta vulgaris*) PI Accessions were evaluated for resistance to the beet cyst nematode (*Heterodera schachtii*) in 1998. Sugar beet seeds were planted 12 May in the greenhouse in 500 cm^3 pots containing naturally infested beet cyst nematode soil (5.3 eggs and larvae per 1 cm^3 soil). The PI accessions were compared to the susceptible check, HM WSPM9. Experimental design was randomized block with five replications. Sugar beet seedlings were separated from soil eight weeks after planting (09 Jul). Beet cyst nematode females and cysts were enumerated from the roots and soil. An analysis of variance was performed on the data, and mean separation was computed using the least significant difference. A numeric score of 0 to 9 was assigned to each PI accession (0 = immune, 9 = highly susceptible).

Beet Cyst Nematode (females & cyst count) data and analysis from 1998 test.

PI Accession	Roots		Soil		Total		Score[1]
NSL 81098	45	abcdefg	342	a	387	a	9
PI 386209	55	abc	319	ab	374	ab	9
PI 386206	44	abcdefg	307	abc	351	abc	9
HM WSPM9	52	abcd	286	abcd	338	abcd	9
NSL 93279	30	cdefgh	285	abcd	315	abcde	9
PI 232892	33	bcdefgh	270	abcde	303	abcde	8
PI 491195	50	abcde	241	abcdef	291	abcdef	8
PI 357359	67	a	221	bcdefg	288	abcdef	8
PI 486360	34	bcdefgh	249	abcde	283	abcdefg	8
PI 355961	46	abcdef	227	abcdefg	273	abcdefgh	8
PI 264152	47	abcdef	226	abcdefg	273	abcdefgh	8
PI 286501	59	ab	212	bcdefg	271	abcdefgh	8
PI 285592	38	bcdefgh	232	abcdefg	270	abcdefgh	8
PI 535839	44	abcdefg	209	bcdefg	253	bcdefghi	7
PI 490993	51	abcde	200	cdefg	251	bcdefghi	7
PI 142815	47	abcdef	193	cdefg	240	cdefghi	7
PI 486356	59	ab	177	defg	236	cdefghi	7
NSL 80223	45	abcdef	186	defg	231	cdefghi	6
PI 263865	42	abcdefgh	188	defg	230	cdefghi	6
PI 368376	48	abcde	182	defg	230	cdefghi	6
PI 286502	24	efgh	202	bcdefg	226	cdefghi	6
PI 269309	43	abcdefg	177	defg	220	defghi	6
PI 142813	29	cdefgh	187	defg	216	defghi	6
NSL 93277	19	fgh	193	cdefg	212	defghi	6
NSL 95217	27	defgh	183	defg	210	defghi	6
PI 357357	46	abcdef	157	efg	203	efghi	6
PI 357354	31	cdefgh	131	fg	162	fghi	4
PI 232894	34	bcdefgh	120	g	154	ghi	4
PI 142809	30	cdefgh	120	g	150	hi	4
PI 507849	17	gh	122	g	139	i	4
PI 142808	14	i	117	g	131	i	3
LSD (0.05)	28		117		130		

[1] Score: 0 = immune, 9 = highly susceptible to beet cyst nematode.

Appendix 2

1999 CGC Evaluations of NPGS PIs for Resistance to Sugar Beet Cyst Nematode

S. Hafez, M. Larkin, R. Portenier and K. Hara – University of Idaho, Parma, ID 83660

EVALUATION OF THIRTY SUGAR BEET (*Beta vulgaris*) PI ACCESSIONS FOR RESISTANCE TO BEET CYST NEMATODE (*Heterodera schachtii*), 1999: Sugar beet seeds were planted 03 May in the greenhouse in 500 cm^3 pots containing naturally infested beet cyst nematode soil (4.3 eggs and larvae per 1 cm^3 soil). Thirty PI accessions were compared to the susceptible check, HM WSPM9. Experimental design was randomized block with six replications. Sugar beet seedlings were separated from soil ten weeks after planting (13 Jul). Beet cyst nematode females and cysts were enumerated from the roots and soil. An analysis of variance was performed on the data, and mean separation was computed using the least significant difference. A numeric score of 0 to 9 was assigned to each PI accession (0 = immune, 9 = highly susceptible).

PI Accession	Beet Cyst Nematode (females & cyst count)						Score[1]
	Roots		Soil		Total		
PI 116808	22	cd	316	a	338	a	9
PI 546396	43	a	270	ab	313	ab	9
PI 179176	35	ab	248	abc	283	abc	9
PI 174060	16	cdefgh	260	ab	276	abc	9
PI 172734	18	cdefg	254	ab	272	abc	9
PI 172730	7	efghi	265	ab	272	abcd	9
PI 173841	8	defghi	244	abcd	252	abcde	9
PI 271441	19	cdef	225	abcde	244	abcdef	9
Ames 8300	24	bc	216	abcdef	240	abcdef	9
PI 173843	18	cdefg	210	abcdef	229	abcdefg	9
PI 164172	12	cdefghi	215	abcdef	227	abcdefg	9
PI 215577	20	cde	200	bcdef	220	bcdefg	9
PI 504173	19	cdef	200	bcdef	219	bcdefg	9
PI 120701	9	defghi	196	bcdefg	205	bcdefgh	9
PI 268365	12	cdefghi	193	bcdefg	205	bcdefgh	9
PI 193458	10	cdefghi	188	bcdefgh	198	bcdefghi	9
PI 120690	9	defghi	186	bcdefgh	195	cdefghi	9
HM WSPM9 (susceptible check)	12	cdefghi	182	bcdefgh	194	cdefghi	9
PI 169020	9	defghi	180	bcdefgh	189	cdefghi	9
PI 142810	6	fghi	171	bcdefgh	177	cdefghi	9
PI 277270	12	cdefghi	143	cdefghi	155	defghij	8
PI 486357	4	hi	142	cdefghi	146	efghij	7
PI 442069	7	efghi	139	cdefghi	146	efghij	7
NSL 93284	3	hi	138	defghi	141	efghij	7
PI 546534	8	efghi	132	efghi	140	efghij	7
NSL 95218	2	i	133	efghi	135	fghij	6
PI 504199	5	ghi	108	fghi	113	ghij	5
PI 257280	9	defghi	88	ghi	97	hij	4
PI 504180	6	fghi	79	hi	85	ij	4
PI 518303	1	i	55	i	56	j	2
PI 546455	0	i	50	i	50	j	2
LSD (0.05)	14		110		117		

[1] Score: 0 = immune, 9 = highly susceptible to beet cyst nematode.

SUGAR BEET RESEARCH

2001 REPORT

Section C

U.S.D.A., A.R.S., Western Regional Plant Introduction Station
Pullman, Washington

Dr. Alan Hodgdon, *Beta* Curator

This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 290)

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Status Report on the U. S. *Beta* Collection, 2002
by A. Hodgdon C3

Status report on the U. S. *Beta* collection, 2002

Dr. Alan Hodgdon
USDA, ARS, Western Regional Plant Introduction Station, Pullman, WA

This report is on the Calander Year 2001 activities of the *Beta* germplasm collection at the Western Regional Plant Introduction Station (WRPIS), Pullman, WA. Fifty accessions were started for seed increase at WRPIS in 2001. Fifty-eight accession were harvested from plants started in either 1998, 1999, 2000, or 2001. Two accessions in the increase program in 2001 did not germinate. One of these we will try to regrow, but the other accession has no seed left, and what remains of this accession is a good quantity of open pollinated seed. Germination tests of the 2001 increase seed will be done in 2002. The *Beta* increase program has a carryover of fifty-four accessions from 2001 to 2002 mostly due to incomplete flower induction during the growing season. Flowering 'de-induction' seems to occur when growth temperatures, especially night temperatures, are too warm. This problem has been solved in some of the greenhouse rooms where we can control the temperature well. De-induction is also a problem in field increases of wild *Beta* accessions. We now have nineteen greenhouse rooms usable for year round seed increases, and four other rooms that can be used part of the year. These rooms give a potential increase of about sixty accessions per year. We are currently investigating techniques and protocols to avoid the induction reversal problem.

One hundred sixty-two accessions were tested for germination percent and seedling vigor in 2002. Of the lines tested, 94 were from increases done at WRPIS in 1999, 2000, and 2001. The rest were new accessions obtained from breeders. Only one of the accessions tested had less than 50% viability, but seventy-eight had greater than 50% dormancy. Much of the dormancy was in newly increased seed. There is a large backlog of *Beta* accessions that needs germination testing. Only 1140 of 2434 accessions (46%) have been germination tested in the last ten years.

A total of 354 accessions of *Beta* were distributed in 2001 in 28 seed orders. We acquired 105 new accessions, 99 of these were from the National Seed Storage Laboratory. In 2001 we continued the accession evaluation program with seven evaluators participating from stations around the United States. Accessions were evaluated for response to seven diseases, three insect and nematode pests, and for a series of agronomic traits. Twenty or thirty accessions were done by each evaluator depending on the resources of the evaluator. Evaluation data is entered into GRIN by WRPIS staff. In 2001 I compiled descriptor information on 520 accessions from field a greenhouse notes taken in the WRPIS increase program since 1993. I also started a systematic charting of seventeen descriptors that can be taken during accession increases. This data has been put on a spreadsheet along with seedling emergence, and will be entered into GRIN. Pictures are being taken of accessions being increased and are entered into GRIN. I have finished a draft of the Beta Operations Manual which will continue to be a work in progress.

In 2002 we will continue the seed increase program in both greenhouse and field plots. We had two experiments to access protecting our over-wintering field plots that gave very encouraging results showing that we may be able to produce good field increases of sugar beet seed. In 2002 we will continue the accession evaluation with seven evaluators doing thirty accessions each for the same diseases, pests, and agronomic traits as in 2001. In 2001 we received forty-one seed samples of accessions either missing from our collection or in critically low supply. These have been added to our highest priority increase list, and will be grown as soon as possible.

SUGARBEET RESEARCH

2001 Report

SECTION D

U.S. Department of Agriculture, Agricultural Research Service,
Northern Crop Science Laboratory, Sugarbeet & Potato Research Unit,
1307 N 18th St., P.O. Box 5677, Fargo, North Dakota 58105-5677

Telephone Number: (701) 239-1350
Fax Number: (701) 239-1349

SUGARBEET AND POTATO RESEARCH UNIT

Dr. J.C. Suttle, Research Leader
Plant Physiologist
Dr. L.G. Campbell, Geneticist
Mr. J.D. Eide, Plant Physiologist
Dr. T.L. Friesen, Plant Physiologist
Dr. K.L. Klotz, Plant Physiologist
Ms. R.L. Stolzenberg, Microbiologist
Dr. J.J. Weiland, Plant Pathologist

Cooperation:

North Dakota State University, Fargo, ND
Sugarbeet Research and Education Board of MN and ND
University of Minnesota, Crookston, MN
USDA, Agriculture Research Service, Fort Collins, CO

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Identification of the Sucrose Metabolizing Enzymes Responsible for Sucrose Losses During Sugarbeet Development and Storage
By K.L. Klotz (Project 650).. D13

PUBLICATIONS

Abstract of Papers Presented or Published

CAMPBELL, L.G. Development of alternative control strategies for the sugarbeet root maggot. Journal of Sugar Beet Research. 2001. vol. 38(1) p. 60.

Sugarbeet root maggot is a major insect pest of sugarbeet. The primary control method has been the use of insecticides to reduce larval populations in sugarbeet fields. The almost exclusive use of organophosphate insecticides (chlorpyrifos and terbufos) is conductive to the development of insecticide resistant root maggot. Possible alternatives to these insecticides include the use of biological control agents and the development of germplasm with host plant resistance. Two resistant germplasm lines, F1015 and F1016, have been developed by ARS. A comparison of hybrid performance with and without chlorpyrifos, four experimental hybrids with F1015 as the pollen parent and no insecticide produced between 133 and 584 pounds recoverable sugar per acre less than the same hybrids with chlorpyrifos applied at planting. In contract, not applying chlorpyrifos to a commercial hybrid reduced recoverable sugar yield by 1096 pounds. Among the biological agents that have been evaluated for root maggot control, the entomopathogenic fungus *Metarhizium* appears to have the most promise. Under moderate root maggot infestations (1995-1999), the highest yielding *Metarhizium* treatment produced 24.8 tons per acre, compared with 24.9 tons per acre from the chlorpyrifos treatment and 22.7 tons when no insecticide was used. Current research with *Metarhizium* will focus on development of commercially useful application techniques and evaluations in diverse environments.

CAMPBELL, L.G., and K.OTZ, K.L. Impact of root diseases on storage: Extractable sugar and respiration. 2001 Sugarbeet Research and Extension Reports, Cooperative Extension Service, North Dakota State University. 2002. vol 32. p 181-182.

In recent years, sugarbeet root diseases have become more prevalent throughout Minnesota and eastern North Dakota. *Rhizomania* was positively identified in souther Minnesota in 1996 and has since been observed in the southern Red River Valley of North Dakota and Minnesota. *Rhizomania* resistant hybrids are available and provide the only practical control. Because of its persistence in the soil and the lack of effective control methods available, *Aphanomyces* is especially threatening. Any increase in root rots in the field will be accompanied by an increase in the proportion of roots with rot that are placed in storage piles. Information on the effects of root-rot severity on initial quality and storability would assist growers and agriculturalists when determining the disease severity that would justify not harvesting a field or if roots from diseased fields should be segregated and processed first. Respiration rates of roots with moderate or severe *Aphanomyces* were substantially higher than respiration rates of healthy roots. The higher respiration rates are not only indicative of high sugar loss but would increase storage pile

temperature and increase sugar lossses of adjacent healthy roots. Neither *Rhizomania* nor *Aphanomyces* resistance appeared to be associated with higher respiration rates, in the absence of the diseases.

K.OTZ, K.L., and CAMPBELL, L.G. Impact of root diseases on storage: carbohydrate impurity formation. 2001 Sugarbeet Research and Extension Reports, Cooperative Extension Service, North Dakota State University. 2002. vol 32. p 183-187.

The impact of root disease on the accumulation of carbohydrate impurities during sugarbeet storage was examined. Field grown sugarbeet roots exhibiting varying degrees of root rot at time of harvest were stored at 4°C and 95% relative humidity for 18 and 85 days. Roots exhibiting symptoms of severe root rot had significantly elevated concentrations of glucose and fructose, and a significantly reduced concentration of trisaccharide impurities. Raffinose was the major trisaccharide present, regardless of the severity of root rot symptoms or time in storage, and was the only trisaccharide evident in healthy sugarbeet roots. Severely rotted roots also contained the trisaccharides, 1-kestose and 6-kestose. The duration of storage had little impact on root glucose and fructose concentrations regardless of the severity of root rot symptoms. Trisaccharide content, however, declined during storage for both healthy and diseased roots.

KLOTZ, K.L., AND FINGER, F.L. Sucrose catabolism during sugarbeet root development: changes in sucrolytic isoenzyme activities and carbohydrate accumulation during growth. Journal of Sugar Beet Research. 2001. v. 38(1) p. 81.

Three enzyme activities are responsible for nearly all sucrose catabolism in sugarbeet roots. Acid invertase, alkaline invertase and sucrose synthase activities convert sucrose to the hexose sugars glucose, fructose and UDP-glucose. Sugarbeet roots contain at least two soluble acid invertase isoenzymes, an insoluble acid invertase activity, two alkaline invertase isoenzymes and two sucrose synthase isoenzymes as determined by activity staining of isoelectric focused polyacrylamide gels. Each isoenzyme exhibited a unique pattern of developmental expression. Acid invertase isoenzymes were most active in the roots of young plants and were the predominant sucrolytic activity in roots of seedlings. Activity of the major acid invertase isoenzyme paralleled root growth rate and was inversely correlated to sucrose accumulation. The predominant sucrolytic activity during all but the earliest stages of growth was a sucrose synthase isoenzyme. A second sucrose synthase isoenzyme became evident as roots approached maturity. Nearly all sucrose accumulation and enlargement of the taproot occurred when sucrose synthase was the major sucrolytic activity. Alkaline invertase was a minor sucrolytic activity in sugarbeet roots and was present at all but the early stages of development. The different patterns of expression for the major sucrolytic isoenzymes of sugarbeet roots suggest that they are likely to have different functions in the developing root.

KLOTZ, K.L., FINGER, F.L., SHELVER, W.L., AND EIDE, J.D. Sugarbeet root sucrose synthase isoforms are tetramers composed of varying ratios of two putative subunits. American Society of Plant Biologist Annual Meeting. 2001. p.121. Abstract # 551.

Sucrose synthase (UDP-D-Glc: D-Fru 2-α -glucosyltransferase, EC 2.4.1.13) catalyzes the transfer of a glucose residue from sucrose to uridine 5' -diphosphate (UDP) to yield UDP-glucose and fructose. Sucrose synthase is the major sucrolytic enzyme in sugarbeet root and may play a role in the regulation if sink strength and carbon partitioning to the root. Sucrose synthase was isolated from mature sugarbeet root tissue by a combination of ammonium sulfate fractionation, size exclusion chromatography, ion chromatography and affinity chromatography. Polyclonal antibodies were raised against the purified enzyme and used for subsequent Western analysis of the protein at different stages of sugarbeet root development. Native sucrose synthase had an apparent molecular weight of 320 kDa. SDS-PAGE revealed the presence of the two distinct protein bands with apparent molecular weights of approximately 84 and 86 kDa. The native protein, therefore, is a tetramer. Both subunits were found to have a similar amino acid composition and may arise from separate, but very similar genes or from different posttranslational modification of a single gene product. Different isoforms of sucrose synthase were found throughout root development due to differences in the relative proportion of the two subunits. The smaller putative subunit predominated in sucrose synthase isoforms isolated from young sugarbeet roots; the larger putative subunit predominated in sucrose synthase isoforms isolated from mature sugarbeet roots.

KLOTZ, K.L., AND FINGER, F.L. Activity and stability of a soluble acid invertase from sugarbeet roots. Journal of Sugarbeet Research. 2001. v. 38. p. 121-137.

A soluble acid invertase from sugarbeet roots was partially purified and some of its biochemical and physical properties characterized. This invertase isoenzyme has a K_m for sucrose of 8.9 mM and is not inhibited by fructose. The enzyme exhibits a plateau of activity at pH 5.0 to 5.5, and is activated 7.5-fold at pH 3.0, possibly due to the loss or decreased effectiveness of an inhibitor. The enzyme is unstable at pH values equal to or greater than 7.5 at high ionic strength. While short incubations at pH 3.0 and 4.7 caused minor losses in activity, prolonged exposures to these pH conditions seem to activate the enzyme. The enzyme exhibits a sharp temperature optimum at 35°C. At temperatures above or below this optimum, enzyme activity declines rapidly, although 16% of its activity is retained at 5°C. Rapid and irreversible inactivation occurs at 40°C and above. Partial inactivation occurs at 40° to 50°C, while complete inactivation occurs at 55°C and above.

WEILAND, J.J. *Cercospora* leaf spot of sugarbeet: new tools to study and old foe. Sugar Producer Magazine. 2002. vol. 20(3) p. 22-23.

Triphenyltin hydroxide (TPTH) has been used extensively in the Northern Great Plains in recent years for the control of *Cercospora* leaf spot on sugarbeet. Although mancozeb and, to a lesser extent, the benzimidazole fungicides often are

implemented in conjunction with TPTH for optimum leaf spot control, TPTH continues to be the most widely used compound for control of the disease. Eminent™ (tetraconazole) has been used on sugarbeets in Minnesota and North Dakota only in the past few years, preliminary testing for tolerance to this fungicide is presented in this year's study. Testing in our USDA-ARS Fargo laboratory for *Cercospora* that was isolated from leaf spot in the sugarbeet fields in North Dakota and Minnesota for the tolerance or resistance to fungicides first revealed tolerance to TPTH in 1994. Testing for baseline tolerance to tetraconazole is also beginning this year, as this represents new chemistry available to the grower for the control of leaf spot disease. The results of the study found similar presence of fungicide resistant *C. beticola* isolates to previous years.

WEILAND, J.J. Esterase isozyme and DNA fingerprinting distinguish *Cercospora beticola* races in C1 and C2. 31st General Meeting of the American Society of Sugar Beet Technologists. 2001. p. 127.

Physiological races C1 and C2 of *Cercospora beticola* originally were distinguished by the differential leaf spot symptoms they incited on sugarbeet. Supernatants of liquid stationary cultures of these two *C. beticola* races were the source of secreted esterase in this study, with the fungal mycelia from these cultures being used as a source of genomic DNA and non-secreted esterase activity. Using both the random amplified polymorphic DNA (RAPD) and the amplified fragment length polymorphism (AFLP) techniques, DNA polymorphisms distinguishing these two races were shown to exist. Esterase activity was detected in both culture supernatants and extracts prepared from fungal mycelia. In both denaturing and native polyacrylamide gel electrophoresis, a major esterase activity was produced by race C2 that was of slower electrophoretic mobility as compared to the major esterase activity produced by race C1. The possible involvement of esterase activity in the observed virulence differences of the two races on inoculated sugarbeet is discussed.

WEILAND, J.J, AND YU, M.H. Molecular genetic tagging of resistance in sugarbeet to root know nematode (*Meloidogyne* species). 31st General Meeting of the American Society of Sugar Beet Technologists. 2001. p. 233.

Incorporation into sugarbeet (*Beta vulgaris* L.) of resistance to root knot nematode has been an ongoing project at the USDA-ARS laboratory in Salinas, CA. Resistance discovered in *Beta maritima* appears to be simply inherited and is effective against multiple species and races of nematode belonging to the genus *Meloidogyne.* Sugarbeet population accession 1568 segregating for a resistance to root knot nematode was used in an effort to develop molecular genetic markers tagging this resistance. Preparations of DNA were made from leaves of plants that exhibited susceptibility or resistance to nematode after inoculation in a greenhouse. Pooled DNA of segregants was used to identify markers associated with the resistance using the random amplified polymorphic DNA technique. At least 5 DNA markers were obtained that co-segregated with nematode resistance. One marker was coupled in repulsion to the resistance. The use of this marker in the incorporation of nematode resistance into elite sugarbeet breeding germplasm is discussed.

POLYMERASE CHAIN REACTION (PCR)-BASED DETECTION OF *APHANOMYCES COCHLIOIDES* USING ACTIN GENE SEQUENCES.

Project 620

John J. Weiland

The polymerase chain reaction (PCR) is a DNA based technique for amplifying specific sequences from the genomes of organisms. PCR technology has impacted many fields of biology, including the area of disease diagnosis in both plants and animals. Diagnostics using the PCR are sensitive and highly discriminatory, since they target genome regions whose DNA sequences have diverged throughout evolution. PCR-based diagnostics also require little time for a result to be secured (within one to two days), making them attractive to high-throughput diagnostic laboratories. More recently, exquisite quantitation of pathogens has been made a reality by the added technology of "real-time" PCR. Current budgetary plans within our ARS unit call for the purchase of a real-time PCR system in FY2002 or 2003.

The interests in our laboratory include the development of novel diagnostic tools for disease-causing fungi in sugarbeet with a special emphasis on the highly destructive pathogen *Aphanomyces cochlioides*.. For this reason, we designed our PCR assay for the discrimination of sugarbeet fungal pathogens upon DNA sequences of the actin and ribosomal RNA (rRNA) genes. The rRNA genes of all organisms harbor sequences that permit that organism to be "fingerprinted" according to that gene sequence. This fingerprinting analysis was applied to Aphanomyces populations that were collected in the U.S. ranging from the northern Red River Valley to (now abandoned) sugarbeet growing regions of Texas. The analysis revealed that *Aphanomyces cochlioides* populations in the central states of the U.S. are genetically uniform. Using a parallel technique of random amplified polymorphic DNA (RAPD) analysis, limited genetic diversity was detected in a field near Buffalo Lake, MN. In investigations which focused on additional isolates of *A. cochlioides* from this region in 2001, the genetic diversity detected was found to be wide-spread throughout the sampled field (Figure 1).

Also in 2001, nucleotide sequence data was generated from the cloned, polymorphic DNA products (Figure 2). Specific DNA primers for these sequence currently are being designed, which will permit rapid detection of these isolate types. Nucleotide sequence data also was generated from the ITS (highly variable) regions of the rRNA genes of 16 isolates of *A. cochlioides* from around the U.S. Interestingly, no DNA polymorphisms were found in these regions, further indicating the genetic uniformity of *A. cochlioides* relative to other oomycete pathogens, including *A. euteiches*. In collaboration with Dr. Carol Windels (University of Minnesota at Crookston) virulence differences of the various isolates will be determined. Association of DNA fingerprinting types with virulence will be made according to this data. In addition, sequence analysis of these regions will permit the design of DNA primers enabling the specific detection of *A. cochlioides* using polymerase chain reaction techniques.

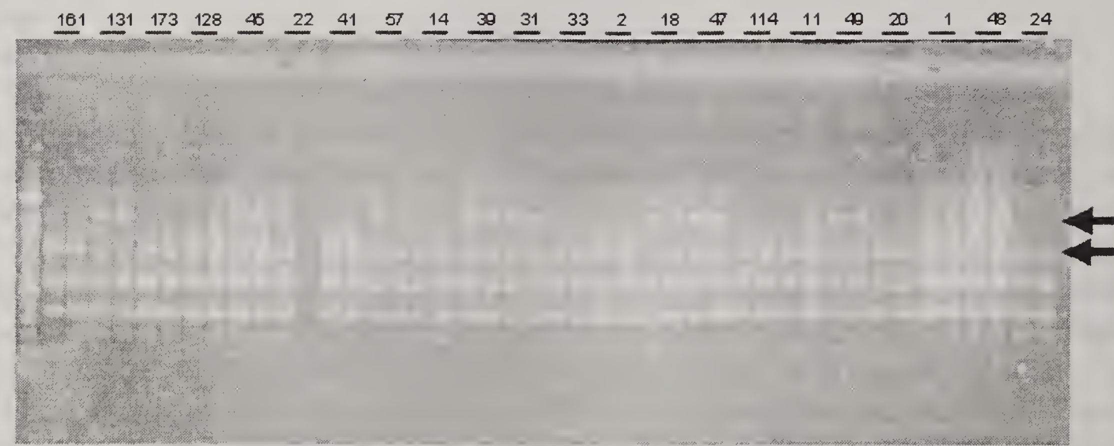

Figure 1. Agarose gel of RAPD analysis showing DNA polymorphism in *A. cochlioides* isolates from a sugarbeet field in southern Minnesota. The arrows point to the DNA bands which are polymorphic within the population.

Figure 2 Cloned DNA from the "high" and "low" DNA polymorphisms illustrated in Figure 1. The arrows point to the DNA band cloned in each case and a RAPD reaction (lane R) was loaded as a size standard.

MECHANISMS OF RESISTANCE IN SUGARBEET TO FUNGAL AND BACTERIAL PATHOGENS

Project 621

John J. Weiland

Enzymes and enzyme inhibitors that accumulate in sugarbeet that is under pathogen stress often are associated with resisting pathogen invasion. Some of these activities are produced to strengthen natural barriers in the plant to pathogen invasion. Others are produces as an arsenal of compounds toxic to the pathogen or as inhibitors of phytotoxins produced by the pathogen. Identification of sugarbeet enzymes, and their corresponding genes, produced in defense against pathogens can further our understanding of the basis for disease resistance. Such knowledge can be used in the selection of germplasm with enhanced pathogen resistance. In addition, the cloning of the genes for defense-related enzymes and inhibitors can lead toward the production of genetically modified (engineered) germplasm for use in sugarbeet breeding programs.

Additionally, protease activity secreted in to the culture media by *A. cochlioides* is being investigated as a virulence component in the production of disease in sugarbeet. Proteases are produced in abundance by Aphanomyces species, including those that infect fish and crayfish. A proteinase inhibitor from lima bean effectively inhibits a subset of the proteases that are separable using gel electrophoresis (Figure 1). Recent evidence indicates that addition of this inhibitor to inoculations of sugarbeet seedlings with *A. cochlioides* significantly reduces the onset of disease. The basis for this inhibition will be the focus of our studies in 2002. Should the inhibitor prove robust in inhibiting the infection of sugarbeet by *A. cochlioides*, the gene(s) for the inhibitor will be cloned using currently available amino acid sequence of the inhibitor protein genes.

In 2001, we looked at secreted esterase activity as a virulence factor in infections of sugarbeet by *C. beticola*. Secretion of the esterase examined appears to be regulated by light in the same manner as that for the well-characterized phytotoxin, cercosporin. Partial purification the activity is underway and antisera production to the purified esterase activity will follow thereafter (Figure 2). Leaf infiltration studies will be done with the esterase in order to determine whether the activity may contribute to virulence of *C. beticola* on sugarbeet. Gene transfer to *C. beticola* will help unravel the role of esterase and other factors in the infection of sugarbeet by this pathogen. This will be done using a technique developed in our lab for the transfer of DNA to Cercospora using *Agrobacterium tumefacies*.

Future studies with *A. cochlioides* will focus on the role of observed protease secreted by the pathogen in pathogen virulence and the nature of the induced esterase in sugarbeet seedlings. Finally, further characterization of the polygalacturonase inhibitor protein (PGIP) genes cloned from various plant species (including *Beta webbiana*) will be done; a cDNA clone will be isolated from *B. webbiana* representing the genomic cloned already analyzed to date.

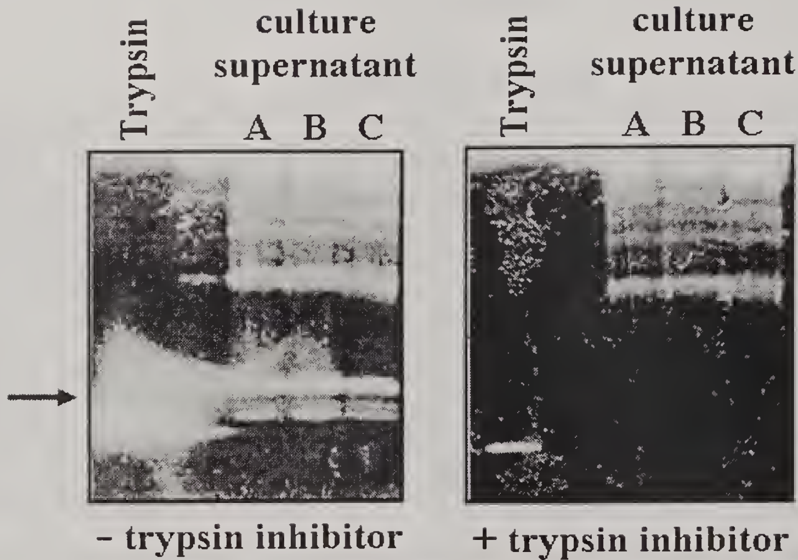

Figure 1. Inhibition of a subset of *A. cochlioides* secreted protease isozymes by lima bean trypsin inhibitor. Isozymes were separated using native gel electrophoresis. The arrow points to the isozymes most highly effected by the inhibitor.

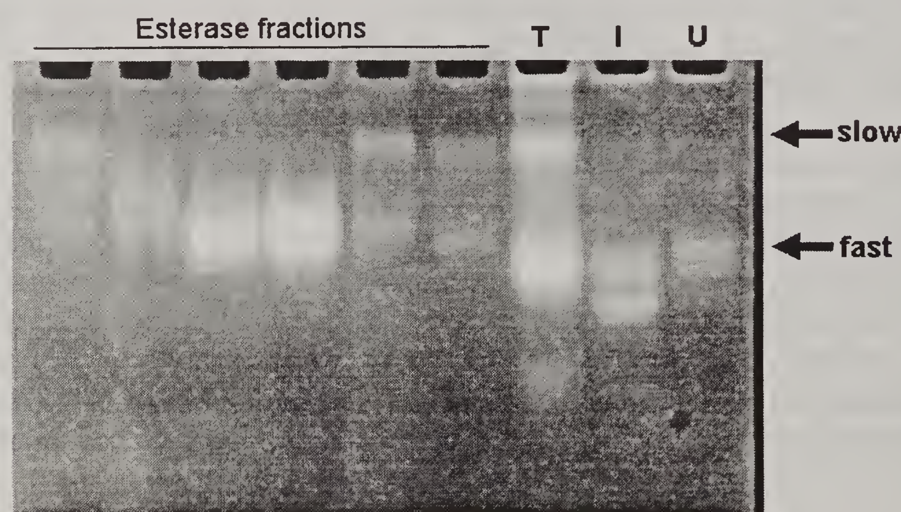

Figure 2 Column purification of esterase activity secreted into culture supernatants by *Cercospora beticola*. The more slowly-migrating isozyme can be separated from the more fast migrating forms. Total esterase (T) from *Cercospora beticola* and from uninfected (U) and infected (I) sugarbeet are co-electrophoresed as controls.

TAGGING OF GENES FOR DISEASE RESISTANCE IN SUGARBEET USING MOLECULAR GENETIC MARKERS

Project 622

John J. Weiland

Markers that tag regions of chromosomes that harbor genes contributing to disease resistance in sugarbeet can be of use in many aspects of research. Such landmarks on the genomic map can be used in marker-assisted selection in sugarbeet breeding programs. In addition the markers can provide information regarding the clustering or lack thereof regarding the distribution of resistance genes throughout the genome. Finally, chromosome markers can be integral tools in the identification of DNA clones that potentially harbor resistance gene sequences. Cloned resistance genes can be analyzed for clues as to their mode of action and can be transferred between plant species using gene transfer technologies.

We have focused early efforts on the tagging of resistance to powdery mildew disease and to root knot nematode. Similar work has already been done in European laboratories in the analysis of resistance to Cercospora leaf spot and Rhizomania diseases. Powdery mildew (*Erysiphe polygoni*) and root knot nematode (*Meloidogyne* spp) resistance in sugarbeet has recently been characterized by ARS colleagues in Salinas, CA. Both genes show promise for the genetic control of several races of the organisms causing these diseases. In collaboration with Drs. Robert Lewellen and Ming Yu, these resistance genes are being tagged using the random amplified polymorphism (RAPD) technique and amplified fragment length polymorphism (AFLP) techniques.

In 2001, with the assistance of a post-doctoral scientist, AFLP markers associated with the *Pm* gene for powdery mildew resistance were obtained (Figure 1) that subsequently led to the production of specific markers based on the AFLP fingerprints. Markers for both the *Pm* gene and the *Mi* gene for root-knot nematode resistance will be made available to research and breeding laboratories following publication of associated results.

Also in 2002, markers tagging resistance to Rhizomania (Rz gene) will be obtained. This will provide publically-available markers for this economically-important gene to sugarbeet breeders. The project also seeks to develop methods for evaluating a sugarbeet population segregating for resistance to Aphanomyces chronic root rot. This has been initiated with the use of oospores, as opposed to zoospores, as inoculum, which should make the technology easier for transfer to breeding laboratories. After characterization of the inheritance of resistance using this procedure, molecular marker tagging then will be applied to this population as well. As an added benefit, the inoculation and rating procedures produced from this work should be useful for screening germplasm for Aphanomyces resistance.

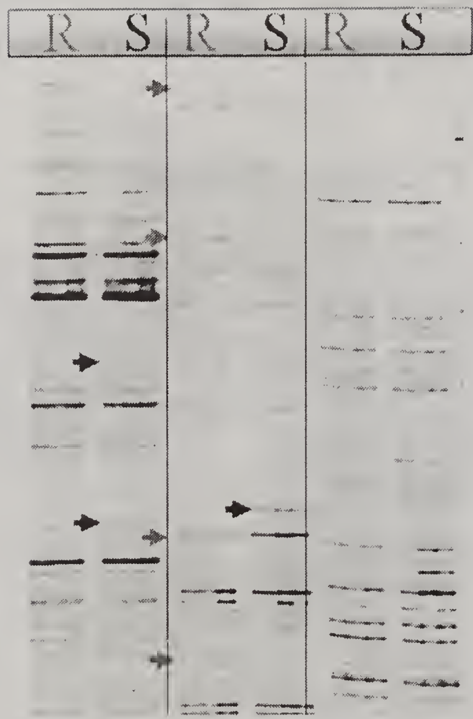

Figure 1 AFLP gel showing DNA polymorphisms associated with resistance to powdery mildew disease in sugarbeet. R = resistant and S = susceptible. Both coupling and repulsion markers were obtained.

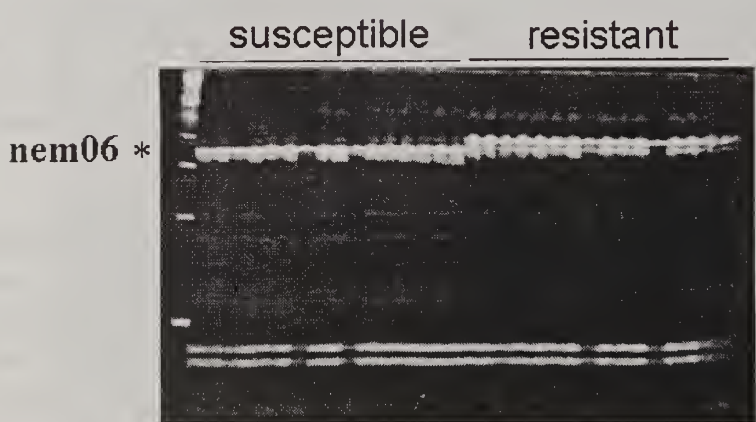

Figure 2 SCAR marker for root knot nematode resistance in sugarbeet. Each lane represents an individual plant typed for reaction to *Meloidogyne* nematode. Polyacrylamide gel electrophoresis was used to separate DNA fragments after digestion with the restriction enzyme *Mse*1. The product that is higher in the gel is associated with the gene for resistance.

IDENTIFICATION OF THE SUCROSE METABOLIZING ENZYMES RESPONSIBLE FOR SUCROSE LOSSES DURING SUGARBEET DEVELOPMENT AND STORAGE

Project 650

Karen L. Klotz

Carbohydrate catabolism is likely to be a key determinant of sugarbeet root yield, sucrose content and postharvest sucrose loss. In other plant species, carbohydrate catabolism has been implicated in the regulation of growth, yield, and carbohydrate content and quality of harvestable plant products. The enzymes responsible for sucrose catabolism in sugarbeet root are known. Acid invertase, alkaline invertase and sucrose synthase are responsible for nearly all sucrose catabolism in sugarbeet root. Unknown, however, are the respective functions of these enzymes and their individual influence on root growth, sucrose partitioning between the root and shoot of the plant, and postharvest sucrose loss. An understanding of the metabolic function and regulation of sucrose catabolizing enzymes is fundamental to understanding sugarbeet root sucrose accumulation and retention. Moreover, an improved understanding of these enzymes may lead to enhanced sucrose yield by suggesting changes in cultural or storage practices or by guiding genetic improvement through selective breeding or genetic transformation.

Previous research examined the relative activity of sucrolytic enzymes during sugarbeet root production and postharvest storage. This research identified sucrose synthase as the predominant sucrolytic activity in sugarbeet roots throughout most of their development and during postharvest storage. To examine the possible role of sucrose synthase in carbohydrate partitioning and sucrose accumulation, sucrose synthase as well as all other major sucrolytic enzyme activities were quantified in three different *Beta vulgaris* lines with different yield and sucrose accumulating capacities. Sucrose synthase, soluble acid invertase, alkaline invertase and insoluble acid invertase activities were measured in the high yielding, low sucrose accumulating fodder beet hybrid 'Monovigor', the commercial sugarbeet hybrid 'H66156', and a low yielding, high sucrose accumulating sugarbeet breeding line 'L19' at five different developmental stages (Table 1). Sucrose, glucose and fructose concentrations were also determined in these three varieties at the same five stages of development (Table 2).

Generally, all three *Beta vulgaris* genotypes exhibited similar developmental patterns of expression for the major sucrolytic activities. Soluble and insoluble acid invertase activities were greatest in young roots and declined to barely detectable levels as roots matured beyond four weeks of age. Alkaline invertase activities were also greatest in young roots, and declined slightly with subsequent root development. Developmental expression of sucrose synthase activity differed slightly for the three genotypes. In the commercial sugarbeet hybrid, H66156, and the sugarbeet breeding line, L19, sucrose synthase activity increased between four and eight weeks of age, while in the fodder beet hybrid, sucrose synthase activity declined. Between eight and sixteen weeks of age, however, sucrose synthase activity was relatively unchanged in all three genotypes.

The predominant sucrolytic activity was the same in all three *Beta vulgaris* genotypes. Sucrose synthase was the major sucrolytic activity at the five developmental stages examined in this study, irregardless of genotype. At four weeks of age, sucrose synthase accounted for 79, 52 and 62% of the total soluble sucrolytic activity in the fodder beet hybrid, H66156 and L19, respectively. The

Table 1: Sucrolytic enzyme activities during root development of the fodder beet hybrid 'Monovigor', the sugarbeet hybrid H66156, and the sugarbeet breeding line L19. Data are means ± standard deviation of ten replicate roots.

Weeks after planting	Soluble Acid Invertase Activity (μmol glucose · g fresh wt^{-1} · h^{-1})			Alkaline Invertase Activity (μmol glucose · g fresh wt^{-1} · h^{-1})			Sucrose Synthase Activity (μmol fructose · g fresh wt^{-1} · h^{-1})			Insoluble Acid Invertase Activity (μmol glucose · g insolubles^{-1} · h^{-1})		
	Fodder	H66156	L19	Fodder	H66156	L19	Fodder	H66156	L19	Fodder	H66156	L19
4	23.9 ± 9.0	11.8 ± 3.0	4.12 ± 1.09	6.57 ± 2.16	4.76 ± 0.89	2.32 ± 1.01	117 ± 33	18.2 ± 9.1	10.4 ± 1.14	5.73 ± 2.64	5.20 ± 5.87	27.0 ± 20.6
6	2.34 ± 0.65	1.83 ± 0.34	0.08 ± 0.15	1.96 ± 0.52	2.23 ± 0.50	1.07 ± 0.30	71.2 ± 14.9	40.0 ± 5.8	3.44 ± 1.06	0.53 ± 0.30	1.92 ± 1.64	5.44 ± 4.17
8	1.44 ± 0.87	0.79 ± 0.88	n.d.	1.33 ± 0.65	2.44 ± 0.79	0.47 ± 0.57	46.8 ± 5.25	67.6 ± 16.9	29.9 ± 4.4	2.88 ± 4.53	1.01 ± 1.75	0.66 ± 0.79
12	0.12 ± 0.12	0.67 ± 0.27	0.18 ± 0.31	2.50 ± 0.86	2.04 ± 0.45	0.69 ± 0.51	58.7 ± 13.1	40.1 ± 18.3	38.8 ± 8.4	3.35 ± 2.08	2.77 ± 2.37	1.29 ± 1.78
16	0.71 ± 0.44	0.01 ± 0.02	0.10 ± 0.06	0.72 ± 0.33	0.56 ± 0.17	0.42 ± 0.34	47.5 ± 10.1	39.5 ± 5.8	16.4 ± 10.9	0.32 ± 0.78	0.12 ± 0.25	3.65 ± 3.02

n.d., not detected

Table 2: Carbohydrate concentrations during root development of the fodder beet hybrid 'Monovigor', the sugarbeet hybrid H66156, and the sugarbeet breeding line L19. Data are means ± standard deviation of ten replicate roots.

Weeks after planting	Sucrose Concentration (μmol · g fresh wt^{-1})			Glucose Concentration (μmol · g fresh wt^{-1})			Fructose Concentration (μmol · g fresh wt^{-1})		
	Fodder	H66156	L19	Fodder	H66156	L19	Fodder	H66156	L19
4	156 ± 44	242 ± 42	128 ± 41	3.96 ± 1.38	5.35 ± 1.87	2.58 ± 1.10	0.140 ± 0.198	0.345 ± 0.302	0.613 ± 0.294
6	185 ± 40	223 ± 9	287 ± 26	4.37 ± 1.64	2.54 ± 0.78	2.28 ± 1.51	0.448 ± 0.370	0.175 ± 0.116	0.372 ± 0.364
8	206 ± 34	272 ± 35	526 ± 34	15.0 ± 6.3	3.48 ± 1.16	2.89 ± 0.60	1.34 ± 1.004	0.184 ± 0.088	0.329 ± 0.180
12	300 ± 49	391 ± 57	471 ± 59	18.1 ± 8.4	3.74 ± 2.19	1.92 ± 0.70	4.36 ± 3.89	0.376 ± 0.245	0.388 ± 0.326
16	329 ± 32	393 ± 60	567 ± 32	0.89 ± 0.47	2.57 ± 1.06	1.49 ± 0.67	0.049 ± 0.066	0.426 ± 0.191	0.443 ± 0.402

preponderance of sucrose synthase activity increased with root age, and in roots eight weeks of age or older, sucrose synthase was responsible for 94 to 99% of total root sucrolytic activity.

Although developmental expression of the individual sucrolytic activities and their relative contribution to total sucrose degrading activity were similar in the three *Beta vulgaris* genotypes, the magnitude of sucrolytic activity differed significantly. Total sucrolytic activity was greatest in the high yielding, low sucrose accumulating fodder beet hybrid. Total sucrolytic activity was lowest in the low yielding, high sucrose accumulating sugarbeet breeding line, L19. The commercial hybrid, H66156, exhibited total sucrolytic activity, yield and sucrose content midway between the fodder beet hybrid and L19. Nearly all differences in total sucrolytic activity between the three genotypes were due to differences in sucrose synthase activity. Quantitative differences in soluble acid invertase and alkaline invertase activities, however, were also noted. Generally, the higher the yield of the *Beta vulgaris* genotype, the greater the total sucrolytic activity and sucrose synthase activity observed. The higher the root sucrose concentration of the genotype, the lower the total sucrolytic activity and sucrose synthase activity found.

Sucrose synthase activity was also examined in six commercial sugarbeet hybrids grown at two locations (Table 3). Roots were grown in northern North Dakota (St. Thomas, ND) and southern Minnesota (Renville Factory District, MN). Both variety and location effects on sucrose synthase activity were observed, suggesting that the expression of sucrose synthase activity is regulated by both genetic and environmental factors. The regulation of sucrose synthase activity by environmental factors will be examined in future research and may elucidate methods to limit sucrose catabolism in sugarbeet roots by cultural methods.

Research is also underway to isolate the gene(s) for sugarbeet root sucrose synthases. Isolation of sucrose synthase gene(s) will allow in-depth study of the regulation and expression of sucrose synthase. Results of these studies may suggest methods to reduce sucrose catabolism during

Table 3: Sucrose synthase activity in six commercial varieties at two locations. Data are means ± standard deviation of four replicates. Representative longitudinal sections of twelve roots were combined to create each replicate.

	Sucrose synthase activity (μmol fructose · mg protein^{-1} · h^{-1})	
Variety	Southern MN	Northern ND
ACH 952	32.4 ± 6.2	11.5 ± 1.5
Beta 3945	16.8 ± 3.4	7.5 ± 1.2
Beta 4600	43.0 ±2.2	8.7 ± 0.9
Beta 4811	15.2 ± 2.1	9.6 ± 2.3
Hilleshog 7083	28.7 ± 1.2	10.2 ± 2.2
VanDerHave 46109	32.7 ± 2.1	14.2 ± 1.1

sugarbeet root production and postharvest storage by alteration in production or storage practices. Alternatively, this research may prove useful for genetic improvement of sugarbeet lines for enhanced sucrose yield by providing a marker for selective breeding or by genetic transformation.

SUGAR BEET RESEARCH

2001 REPORT

Section E

Sugarbeet and Bean Research Unit
Agricultural Research Service - USDA
East Lansing, Michigan

Dr. J. M. Halloin, Plant Physiologist
Dr. J. M. McGrath, Sugarbeet Geneticist
Dr. J. W. Saunders, Research Geneticist, Plants

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USE OF QUADRIS TO CONTROL NATURAL INFESTATIONS OF RHIZOCTONIA CROWN AND ROOT ROT IN MICHIGAN

John Halloin[1,2] and David Johnson[1]

[1] Dept. of Plant Pathology and Dept of Plant Biology Michigan State University, East Lansing, MI. [2] Sugarbeet and Bean Research Unit, USDA-ARS, East Lansing, MI.

Introduction

Rhizoctonia crown and root rot, caused by *Rhizoctonia solani* (Kuhn) AG-2-2, is an economically important disease of sugarbeets in Michigan. Aboveground symptoms are usually not apparent until late June, and disease development continues through July and August, the month of maximum soil temperatures. Although R. solani has the potential to be an aggressive seedling pathogen, it is thought that low soil temperatures in the early season limit it to diseases of more mature plants. Until recently, no chemical controls were available, and disease reduction efforts focused on the development of resistant germplasm and cultural practices such as appropriate crop rotations, reduced cultivation and early planting.

Recently, however, the fungicide azoxystrobin (Quadris, Syngenta Corp.) was approved in Michigan for use against *Cercospora beticola*; it has also shown efficacy against a wide range of fungal and fungal-like pathogens of sugarbeets such as *Aphanomyces cochlioides*, *Pythium* spp. and *Alternaria* spp.. Several recent studies have shown Azoxystrobin to provide significant control of Rhizoctonia crown and root rot in artificially inoculated disease nurseries (i.e. 2,3). These studies, while showing that Azoxystrobin could control Rhizoctonia, leave open the question of whether Azoxystrobin will work in natural situations, or if the control shown is simply a product of the inoculation and spray procedures employed.

Because Quadris is relatively expensive, the proper timing of application(s) for natural epidemics is also an important issue; to maximize control of the disease, as well as potentially lowering costs by combining application(s) with other spray regimes such as herbicide applications or control of Cercospora leaf spot (noting the potential of Azoxystrobin to control Cercospora).

Thus, we were interested in two questions. First, and most importantly, was whether Azoxystrobin is an effective control agent for Rhizoctonia crown and root rot for natural infections. Secondly, the question of the proper timing of Azoxystrobin applications was initially addressed by asking whether an early application at the 6-8 leaf stage (which could be combined with herbicide applications) was as effective as a later application at row closure, which usually coincides with the onset of above-ground symptoms.

Materials and Methods.

Four fields were chosen in 2001 near Bay City, MI: Meylan, Helmrich, Stockmeyer, and Wadsworth (labeled after the cooperating grower) with a history of high Rhizoctonia infestation. Approximately half of one field (Helmrich) was planted with corn the previous year, and half with soybeans; since there was some anecdotal evidence that Rhizoctonia disease was more severe following soybeans, we planted a test in each half of the field at this location.

Four treatments were applied at each location: an early spray at the 6-8 leaf stage; a late spray at row closure; sprayed at both times; and an unsprayed check. The amount of azoxystrobin sprayed (early: 10.5 oz/A in a ten inch band; late: 9.2 oz/A broadcast) varied according to the label recommendations for in-furrow and broadcast applications. While the rate was approximately the same at both times, the amounts of azoxystrobin per unit of surface area of foliar or crown tissue and the amount of azoxystrobin incorporated into the soil was less at the later application. All treatments were replicated 5 times in a Randomized Complete Block design at each location. At Meylan, Helmrich and Stockmeyer locations, ACH 555 (a variety susceptible to Rhizoctonia crown and root rot) was planted. At Wadsworth, two varieties were planted, E17 (susceptible) and B-5736 (resistant): all spray treatments were applied to each variety for a total of 8 treatments per block. Each plot was 6 rows wide and 300-800 m long depending on the location.

Beets were planted and maintained with standard farming practises. Early spraying treatments were applied on 5/30 at the Meylan location and 5/24 at the Helmrich location at the 6-8 leaf stage. Late treatments were applied on 6/26 at both locations. The Stockmeyer and Wentworth locations were sprayed at similar times.

Disease was monitored during the season by counting the number of beets (i.e Disease Incidence) with aboveground symptoms characteristic (heavy wilting, crown and petiole blackening, death) of Rhizoctonia crown and root rot. Other diseases such as Aphanomyces root rot, which can have similar aboveground symptoms, were not present at these sites. Beets were counted once at each location in late July-early August. The four center rows in each plot were assessed.

All six rows were included in each plot for final yields at harvest. Two samples of 10 beets each were sampled from each plot at arbitrary locations and percent sugar and sugar purity were determined by standard methods. Results were statistically analyzed by proc Mixed of SAS V.8.2 (SAS Institute, Cary, NC).

Results

Both tests (following corn; following soybeans) at the Helmrich location had high incidence of Rhizoctonia disease; the following-soybean test had twice the crown and root rot of the following-corn test. The other three locations had low or moderate disease incidences (Table I). At most locations, the lowest incidence was with the combined early and late spray, but this was not significantly different (at the 95% confidence level) than a

single, early spray. A single late spray reduced disease incidence, but in all cases not significantly from the untreated check.

Azoxystrobin treatments had a significant effect on yield only on the Helmrich farm (with a high disease pressure). On the following-Corn test, Early or Early/Late applications of azoxystrobin gave a 0.7 ton/A or 1.1 ton/A increase in yield respectively, over the untreated check. In the following-Soybean test, with a very high disease incidence, the increases in yield over the check were more dramatic; 6.3 T/A with both sprays, 4.5 T/A for the early spray. A substantial (2.8 T/A) yield benefit was seen with the late spray in this trial (Table 1). A single early spray or combined spray had a significantly higher yield than the single late spray in both tests at this location.

In general, sugar percentage and purity were not affected by treatment, although the combined spray at the Meylan farm had a significantly higher sugar percentage and purity than the check (Table I). Differences between treatments for Recoverable white sugar per ton (RWST) and recoverable white sugar per acre (RWSA), derived variables based on yield, percent sugar and purity parameters, reflected the differences in the constituent quantities.

Discussion

Azoxystrobin reduced the incidence of disease at all locations, but the difference between treatments at locations with low to moderate disease pressure was non-significant likely due to the low incidences of disease at these locations. azoxystrobin applications may not be economically beneficial in fields with a low disease pressure. Methods to provide foreknowledge of the amount of inoculum present in the soil before planting would increase the efficacy of spray programs.

In cases of high disease pressure, as seen at the Helmrich farm, azoxystrobin boosted yields dramatically. Interestingly, the early spray, before aboveground symptoms of Rhizoctonia symptoms are visible, had the greatest benefit per unit cost, although an additional late spray gave roughly a two tons/A benefit (early vs. early/late sprays; late spray vs. unsprayed check) in the very heavily diseased following-Soybean test. Since above-ground symptoms of Rhizoctonia crown and root rot are not usually present at the time of the early spray, its efficacy likely indicates that *R. solani* AG 2-2 is active in soils earlier than previously thought. This early-season activity may be very important to yield losses and visible disease incidences later in the growing season. Although *R. solani* AG 2-2 is inactive at cool temperatures (~60°F); sugarbeets tend to be more resistant to Rhizoctonia diseases in general as they age (1). Thus, visible symptoms of disease may be the end product of early, chronic disease initiated when temperatures are not as conducive to disease development, but when tissues are more susceptible.

Since timing of an early spray is not based on aboveground symptoms, improved knowledge of the epidemiology of Rhizoctonia crown and root rot could help time this spray most effectively. Late sprays showed some efficacy against *R. solani* at the Helmrich location, and it is unknown whether increasing the concentration or spray pattern, to concentrate more fungicide into the crowns, for instance, would have been more effective. It is evident that additional research is needed on the epidemiology of *R.*

solani AG 2-2, as well as on the timing, concentration and type of spray required to optimize azoxystrobin use for growers.

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Table I: Quadris Test 2001. Disease incidence (DI) and Yield (Tons/Acre) for each location. Means with different letters are signifigantly different at 95% confidence level. S.E = standard error. * - Stockmeyer yields are expressed as raw lbs. per plot.

Location	Var	Trt	DI / 100 m row		s.e.	Yield (T/A)		s.e.
Helmrich		Check	48.2	A	4.8	18.9	A	0.15
(Corn)		Late	35.7	A	4.8	18.5	A	0.15
		E+L	3.4	B	4.8	20.2	B	0.15
		Early	5.3	B	4.8	19.6	B	0.15
		Average	23.2			19.3		
Helmrich		Check	120.7	A	7.3	14.2	A	0.54
(Soybean)		Late	89.9	A	7.3	17.0	B	0.54
		E+L	5.5	B	7.3	22.5	C	0.54
		Early	9.6	B	7.3	20.7	C	0.54
		Average	56.4			18.6		
Meylan		Check	17.7	A	2.3	15.5	A	0.64
		Late	10.8	A	2.3	16.9	A	0.64
		E+L	1.1	B	2.3	16.9	A	0.64
		Early	2.1	B	2.3	16.3	A	0.64
		Average	7.9			16.4		
Stockmeyer		Check	6.9	A	1.4	12253.3*	A	-
		Early	1.1	A	1.4	12126.7	A	-
		Late	3.2	A	1.4	12653.3	A	-
		E+L	3.3	A	1.4	12780.0	A	-
		Average	3.6			12453.3		
Wentworth		Check	13.0	A	2.3	29.5	a	0.41
		Early	3.4	B	2.3	30.2	a	0.41
		Late	8.1	AB	2.3	29.5	a	0.41
		E+L	2.4	B	2.3	29.4	a	0.41
	E-17		10.3	A	1.6	29.3	a	0.29
	B-5736		3.1	B	1.6	30.0	a	0.29
		Average	6.7			29.7		

Table I: continued. Pct. Sugar = Percent sugar per beet; % CJP = clear juice purity; RWST= Raw White Sugar per Ton ; RWSA = Raw White Sugar per Acre; s.e = standard error. Means with different letters are signifigant letters at the 95% level.

Location	Var	Trt	Pct. sugar		se	% CJP		Se	RWST		se	RWSA		se
Helmrich		Check	17.35	a	0.16	93.70	a	0.46	248.53	a	6.00	4692.3	a	115.4
(Corn)		Late	17.68	a	0.16	94.10	a	0.46	256.94	a	6.00	4753.7	ab	115.4
		E+L	17.77	a	0.16	94.52	a	0.46	260.08	a	6.00	5250.5	c	115.4
		Early	17.72	a	0.16	94.03	a	0.46	256.42	a	6.00	5029.2	bc	115.4
			17.63			94.09			255.49			4931.4		
Helmrich		Check	17.32	a	0.15	92.38	a	0.28	234.32	a	6.58	3337.8	a	198.9
(Soybean)		Late	17.16	a	0.15	92.55	a	0.28	233.95	a	6.58	3960.7	a	198.9
		E+L	17.62	a	0.15	93.31	a	0.28	254.51	a	6.58	5706.0	b	198.9
		Early	17.33	a	0.15	92.96	a	0.28	246.88	a	6.58	5115.0	b	198.9
			17.36			92.80			242.41			4529.9		
Meylan		Check	14.57	a	0.13	91.14	a	0.28	191.38	a	4.04	2956.9	a	158.7
		Late	14.97	ab	0.13	91.67	ab	0.28	204.73	ab	4.04	3461.1	ab	158.7
		E+L	15.61	b	0.13	92.63	b	0.28	219.04	b	4.04	3708.2	b	158.7
		Early	15.10	ab	0.13	92.07	ab	0.28	207.56	ab	4.04	3387.7	ab	158.7
			15.06			91.88			205.68			3378.5		
Stockmeyer		Check												
		Early												
		Late												
		E+L												
Wadsworth		Check	18.88	a	0.21	94.06	a	0.19	274.56	a	4.00	8094.2	a	126.1
		Early	18.73	a	0.21	93.89	a	0.19	271.30	a	4.00	8178.5	a	126.1
		Late	18.78	a	0.24	93.76	a	0.22	271.23	a	4.54	8086.8	a	143.0
		E+L	18.94	a	0.21	94.10	a	0.19	275.69	a	4.00	8102.2	a	126.1
	E-17		18.97	a	0.15	94.23	a	0.14	276.87	a	2.83	8103.3	a	89.2
	B-5736		18.70	a	0.16	93.68	b	0.15	269.52	a	3.03	8127.6	a	95.3
			18.83			93.95			273.20			8115.44		

AGRONOMIC EVALUATION OF SMOOTH ROOT RELEASES AND PROSPECTIVE RELEASES – 2001

J. Mitchell McGrath, Joseph W. Saunders, and Tim M. Duckert
USDA - Agricultural Research Service

The agronomic tests 01BB01 and 01BB02 were planted April 19, 2001 in Range 2 of the Bean and Beet Farm on land previously planted to wheat. Tillage was fall plowing followed by frost tillage in the early spring. All tests were treated pre-emergence with 5.6 pt / acre of Pyramin and 3 pt / acre of Nortron immediately after planting. Fertilizer was 120 lbs / acre of nitrogen, side-dressed. Blocking and thinning were completed by June 7, at an average spacing of 6 inches between plants. Harvest was on October 2, and juice was pressed on October 3. The efforts of Michigan Sugar Lab are gratefully acknowledged for providing the quality sample tests. We considered this test reliable and well executed.

Agronomic evaluations were performed on two sets of materials, grown adjacently, but reported separately in two tests. Test 01BB01, reported here, consisted of eight smooth-root germplasm entries, two recent 'traditional EL' releases (EL50 and EL52), and two check varieties (Hilleshog E17 and US H20) (Table 1). In addition, two developmental germplasm entries (99J19-00 and 99J31-00) were in this test but are reported in Test 00BB02 because their performance was relatively poor, and their results overly skewed statistical comparisons of the smooth-root entries. Test 01BB01 was done to evaluate the progress of smooth-root germplasm development and to identify agronomic limitations in the smooth-root germplasm requiring future work. Most these entries had been tested in prior years, but a full side-by-side comparison was not available.

TABLE 1: Agronomic characteristics of entries from 01BB01 (Smooth-root) sorted by Recoverable White Sugar per Acre (RWSA). Higher numbers are better, except for Amino N and SR (Smooth Root).

Entry	RWSA	RWST	Sucrose%	Tons/Ac	CJP%	Amino N	SR
E17	7295	263.3	18.0	27.7	94.4	9.2	2.6
EL0204	6692	220.6	15.5	30.4	93.7	11.8	2.0
USH20	6378	245.3	16.8	26.0	94.7	9.4	2.4
SR96	6276	246.4	17.2	25.5	93.6	11.6	1.7
SR93	6256	217.0	15.3	28.9	93.8	14.4	1.7
SR95	5810	239.8	16.6	24.3	94.1	9.1	1.6
SR97	5734	250.2	17.2	23.0	94.3	10.6	1.6
SR94	5505	245.2	17.0	22.5	94.0	10.2	1.6
SR87	5471	226.3	15.7	24.2	94.4	9.0	1.5
SR80	5154	227.2	15.8	22.7	94.2	8.6	1.8
EL52	5116	220.3	15.7	23.3	93.2	15.4	2.8
EL50	4999	225.3	15.8	22.2	93.8	11.8	2.9
Mean	5890.5	235.6	16.4	25.1	94.0	10.9	2.0
F value	7.4**	20.0**	22.9**	5.1**	2.9**	3.8**	20.4**
$LSD_{(0.05)}$	730.9	9.3	0.5	3.4	0.7	3.1	0.3
CV (%)	15.2	6.8	5.8	14.9	0.7	29.9	27.6

From the results in Table 1, it is apparent that gains have been made increasing sucrose concentration in more recent smooth-root germplasm lines (e.g. entries with an SR value of 2.0

or less). For instance, SR80, SR87, and SR93 each have more traditional lower sucrose values and were released to industry by 1997, while SR94, SR96, and SR97 are approaching commercial sucrose values. SR96 and SR97 are in the germplasm release process (see below), and these should be available to industry by Spring 2002. EL0204 resulted from smooth-root selections from crosses between rhizomania resistant germplasm and smooth-root germplasm, and further selected for rhizomania resistance in California. EL0204 has shown high RWSA values over the past three years at the Bean and Beet Farm. This line will be released to industry by December 2002. EL52 and EL50 have markedly different selection histories. EL52 was released in 2001 as a seed parent source similar to EL48, but selected further for resistance to Rhizoctonia crown and root rot. EL50 was released in 1994 as a pollinator source germplasm with excellent resistance to *Cercospora* leaf spot.

Parentage and performance of SR96 and SR97 for notice of release

SR96 is a diploid multigerm sibling-derived F_6 population continuously selected for high sucrose and a smooth root (e.g. shallow or no suture and few or no root hairs). SR96 has 3 to 10% improved sucrose concentrations over previous smooth-root releases and retains the extreme smooth root phenotype shown by SR87, SR93, and SR95. SR96 derives from F_1 roots of a sib-mating of 8562-8 (selected from a cross of Aphanomyces resistant germplasm with SP85700), 28M3 (from selections derived from L53 x L19), and 8400051 (a high sucrose percentage line kindly provided by Crystal Seeds, Moorhead, MN). Selections were based on sucrose percentage exceeding the commercial check variety and for roots with well-expressed smooth root phenotypes. Five generations of inter-mating five, three, 17, six, and 17 roots, respectively, resulted in the high sucrose percentage, highly smooth root selection SR96.

SR96 has shown at least 96% of the mean sucrose percentages of the average of three commercial hybrids in three separate years in agronomic trails at Saginaw, MI. SR 96 had an 8 – 10% increase in sucrose percentage relative to similar smooth root varieties SR87, SR93, and SR95 over two years at the same location. SR96 showed excellent resistance in the 2001 Betaseed, Inc. (Shakopee, MN) *Aphanomyces* summer root rot nursery (rating 2.77 mean of three visual readings, compared to 3.27 for the resistant and 4.63 for the susceptible checks, $LSD_{0.05}$ = 0.77), and exhibited excellent *Cercospora* leaf spot resistance in the 2001 USDA-ARS Ft. Collins, CO leaf spot nursery (rating 3.33 mean of three visual readings, compared to 4.20 for the resistant and 5.43 for the susceptible checks, $LSD_{0.05}$ = 0.95). SR96 is susceptible to Rhizoctonia root and crown rot and to rhizomania.

SR97 is a diploid multigerm germplasm with characteristics similar to SR96 but derived from a different breeding strategy with different germplasm sources. SR97 was derived from composite population last selected for increased sucrose percentage after four generations of selection for smooth-roots. Typically, fewer than 5% of the plants in each generation were selected, with a maximum of 11 roots contributing to the final high sucrose, highly smooth-root SR97 release. The composite population used to select high sucrose progeny was developed from 8450 (i.e. SP85700) x L19 and (8450 x US35/2) x L53. The expected composition of SR97 is 44% SP85700, 38% L19, 12% L53, and 6% US35. Self-fertility has not been specifically tested, but both L53 and L19 are self-fertile and this character may be segregating in SR97 as in previous SR releases. SR97 has been tested as 94HS25, 96HS25, and WC960452.

SR97 has shown at least 96% of the mean sucrose percentages of the average of three commercial hybrids in three separate years in agronomic trails at Saginaw, MI. SR 97 had an 8 –

10% increase in sucrose percentage relative to similar smooth root varieties SR87, SR93, and SR95 over two years at the same location. SR97 showed excellent resistance in the 2001 Betaseed, Inc. *Aphanomyces* summer root rot nursery (rating 2.63 mean of three visual readings, compared to 3.27 for the resistant and 4.63 for the susceptible checks, $LSD_{0.05} = 0.77$), and exhibited good *Cercospora* leaf spot resistance in the 2001 USDA-ARS Ft. Collins, CO leaf spot nursery (rating 4.30 mean of three visual readings, compared to 4.20 for the resistant and 5.43 for the susceptible checks, $LSD_{0.05} = 0.95$). SR97 is susceptible to Rhizoctonia root and crown rot, as well as to rhizomania. SR97 is not as smooth as SR96 based on a visual comparison of root suture depth, and its smooth root score is equivalent to SR80 and SR94.

Overall, results of the smooth-root evaluation Test 01BB01 suggest that the primary breeding goal for the coming years should be to improve sucrose content while maintaining high disease resistance, combined in a smooth-root germplasm package.

AGRONOMIC EVALUATION OF PARENTAL GERMPLASM – 2001

Test 01BB02 was primarily conducted to evaluate germplasm arising from recent breeding efforts by JWS to combine disease resistance attributes of 'traditional EL' germplasm releases and breeding lines with the smooth-root traits exhibited by more recent 'SR' germplasm releases and breeding lines. These entries are designated by a 'J' in 10 entry names, as well as the line 96RHS21-7 (TABLE 2). Two of these lines (indicated with an entry prefix ^ in TABLE 2) were actually grown in Test 01BB01, located immediately adjacent to Test 01BB02, and reported here for comparison purposes. Check lines used were Hilleshog E17 and ACH 555. Seven additional germplasm lines were evaluated for their historical value as well as their potential to supply additional genetic combinations for the future. Field operations were exactly those of Test 01BB01.

As expected, agronomic performance of 'J-lines' was similar to traditional EL germplasm materials (e.g. EL48 and 6822-13, TABLE 2), but root conformation was intermediate between traditional EL materials (and commercial germplasm) and the 'SR' smooth-root materials. It was clear that most 'J-lines' were higher tonnage, low sucrose germplasm, which indicates that effort should be placed on increasing sucrose content to levels approaching commercial germplasm without sacrificing root yield potential (or disease resistance). At least a few 'J-lines' were markedly reduced in root yield per acre.

Historical germplasm was tested for a number of purposes. Two entries, Klein E and GW359, represent the most likely ancestors of most, if not all, germplasm used in the U.S. prior to 1970. Klein E was perhaps the most durable variety, having been used for over 50 years in the U.S. in the early part of the 20^{th} century. GW359 is one of the most diverse germplasm sources, and was developed in the mid-20^{th} century from selections derived from a wide population base including *Beta vulgaris* spp. *maritima* (wild beet). GW359 was developed by the former Great Western Co. breeding program, and this line has found use in many programs. Two other lines, 00B041 and 00B042, were selected and increased in 2000 from remnant seed dating prior to 1985. 00B041 (aka Group 5) is a polycross of selections that survived over 20 years of sub-optimal seed storage conditions where less than 10% of similarly stored seed remained viable. 00B042 (aka Special 8) is derived from a fodder x sugar beet hybrid, backcrossed to high sucrose germplasm.

TABLE 2: Test 01BB02 results of 20 entries ranked according to Recoverable White Sugar per Acre (RWSA). Higher numbers are better, except for Amino N and SR (Smooth Root). ^ indicates entry was in adjacent Test 01BB01. SR scores were a visual rating from 1 (= very smooth root) to 4 (= extremely deep suture) determined from all beets harvested in a plot.

Entry	RWSA	RWST	Sucrose%	Tons/Ac	CJP%	Amino N	SR
E17	6541	255.7	17.6	25.6	94.4	7.8	1.8
00B041 (Gp5)	6212	215.9	15.2	28.8	93.8	12.3	2.1
96RHS21-7	5999	236.3	16.4	25.4	94.2	9.1	1.3
GW359	5711	228.4	16.1	25.0	93.6	9.2	1.8
CRYSTAL 555	5512	250.0	17.5	22.0	93.6	12.5	2.4
98J23-00	5428	232.4	16.3	23.4	93.5	11.9	2.0
00B042 (Sp8)	5384	240.2	16.6	22.4	94.2	10.0	2.3
98J34-01	5324	224.0	16.0	23.8	92.8	16.1	2.1
96J09-1	5299	220.3	15.6	24.2	93.4	12.9	2.0
98J41-01	5299	228.2	16.1	23.2	93.4	13.3	2.0
97J27-00	5232	224.8	15.9	23.4	93.5	9.9	1.9
6822-13	5057	228.4	15.9	22.2	94.2	9.8	2.4
EL48	5032	214.9	15.1	23.4	93.7	11.5	2.6
96J09-2	5030	222.8	15.7	22.6	93.5	13.8	1.9
^99J19-00	4814	214.9	15.2	22.4	93.5	10.9	2.0
SP85303	4581	228.7	16.2	19.9	93.3	11.0	2.4
98J11-01	4501	215.5	15.3	20.9	93.2	13.7	2.5
KLEIN E	4029	208.3	14.9	19.4	93.2	11.2	3.1
98J24-01	3511	241.6	16.8	14.5	94.0	9.6	1.8
^99J31-00	3105	217.7	15.3	14.2	94.0	10.4	2.0
Mean	5078.2	227.5	16.0	22.3	93.7	11.3	2.1
F value	7.2**	17.6**	18.8**	5.8**	2.9**	4.2**	6.3**
$LSD_{(0.05)}$	879.6	8.3	0.5	4.0	0.7	2.7	0.4
CV (%)	21.3	6.1	5.2	20.7	0.7	26.0	23.4

<u>Future directions for East Lansing breeding program</u>

Multi-location tests across the US in 2001 demonstrated equivalent agronomic performance of smooth-root releases as seen in East Lansing, and the assistance of many cooperators was invaluable. The combined results will be summarized and submitted for publication in the J. of Sugar Beet Research (data is available from JMM). Short-comings of the smooth-root lines are generally low sucrose content, with the exception of SR96 and SR97, high susceptibility to Rhizoctonia crown and root rot, high susceptibility to Rhizomania, with the exception of EL0204, and susceptibility to Curly Top. Insights gained from multi-location tests include reasonable tolerance to bolting under California conditions, apparent segregation for root aphid tolerance, reasonable Cercospora leaf spot and excellent Aphanomyces resistance, and good emergence. Soil tare was reduced by as much as half (to ca. 2% tare) over commercial checks in areas where this trait was examined, except in the heavy soils of the Bean and Beet Farm in Saginaw, MI.

EVALUATION OF SOIL TARE BETWEEN TRADITIONAL AND SMOOTH ROOT RELEASES IN MICHIGAN

J. Mitchell McGrath and Tim M. Duckert
USDA - Agricultural Research Service

Smooth-root (SR) beets have a number of potential advantages in reducing soil tare transportation and disposal costs, reducing spread of soil borne diseases and pests, and perhaps reducing tap root breakage at harvest and the subsequent increase in respiration of wounded beets in factory piles. Although smooth-root breeding was begun in the 1930's, it was not until the 1990's that the first SR sugarbeet releases were available. The primary test for SR selection has been a visual rating of the depth of the suture that vertically spirals along either side of the harvested root, with SR beets having little or no observable suture in the extreme case, but always with a reduced suture compared with commercial and other traditional sugar beet germplasm. In a few instances actual tare has been measured. Most often individual beets were washed and re-weighed such that the difference represented a soil tare measure, and in these cases up to a 50% reduction in tare was obtained. In other cases where tare samples were obtained in more realistic harvest settings, soil tare was also reduced.

The purpose of this test (01BB06) was to gain a first approximation into soil tare measurement from harvest to processing, since soil could be lost at many points along this stream. Here we compared soil lost from a simulated harvest to processing stream at three different stages. The first simulated transfer of beets was from the harvester to the transport vehicle, and would represent soil left at the site of harvest (e.g. first tare, TABLE 1). The second point simulated tare from the transport vehicle to the beet piler at the piling grounds (second tare), and would represent the soil needing transport away from the piler. The third tare dirt collection simulated soil lost from washing beets in the processing flume, and would represent the amount of soil requiring disposal by the factory.

FIGURE 1: Collection of first and second soil tare weight data by sequential transfer of harvested beets through an intermediate harvester bin, collecting and weighing soil collecting on tarps beneath each harvester. A third tare was obtained from soil collected from individually washed beets taken from the bin at the right.

The soil tare test was conducted as a large plot trial, with four-row plots (500 ft) replicated four times with four entries, two SR beet entries and two entries with deep sutures. Moisture in this heavy clam-loam soil was 27% (wt/wt) at harvest, and soil clods were often harvested with beets, particularly with SR94 where the beets were smaller on average than the other three entries. SR94 showed unexpectedly high first and second soil tare weights (TABLE 1), perhaps because of their smaller size. EL52, the least smooth of the entries, showed the lowest first and second tare values (TABLE 1B). Although the first and second soil tare differences between entries were statistically significant, there appeared to be little or no correlation with SR score. The reason for the failure to detect lower first and second soil tare in SR beets is not clear, but may be due to soil conditions (this soil may represent a worst case clay content among the range of soils in beet growing areas), beet size, and the techniques of measurement. In any case, the large variation within entries (e.g. CV values), suggests that better measurement techniques should be developed.

Differences in dry soil per beet (TABLE 1) were statistically significant between entries, and were correlated with SR vs. non-SR beets. This result suggests that SR beets, at a minimum, will reduce the soil disposal load from the processing plume at the factory.

TABLE 1: A) Agronomic values associated with the soil tare test (all weight measurements are expressed in pounds). B) Percent tare for first and second simulation tests.

A)

Entry	Yield / 500 ft. row	First tare	Second tare	No. of washed beets	Washed beet wt	Dry soil wt	**Dry soil / beet**	SR
EL52	1690	30.9	24.5	21.0	48.0	7.6	**0.37**	3.5
E17	2499	76.7	46.2	24.0	48.3	8.4	**0.35**	2.3
SR94	2253	91.3	50.2	29.0	47.0	8.2	**0.28**	1.5
SR95	2356	59.2	42.0	27.8	48.3	7.5	**0.27**	1.3
Mean	2180	63.7	40.3	25.5	47.9	7.9	**0.32**	2.1
F value	17.7**	6.9**	5.5*	14.9**	0.2 ^{ns}	1.7 ^{ns}	**4.0***	6.1*
LSD $_{(0.05)}$	293	30.4	14.8	2.9	5.7	1.2	**0.10**	1.3
CV (%)	16.0	46.2	33.1	14.6	6.0	8.7	**19.4**	55.6

B) Percent first and second tare. First tare was meant to simulate soil collected at point of transfer between harvester and transport vehicle, and second tare was meant to simulate soil collected at point of transfer between transport vehicle and the piling grounds.

Entry	% 1st Tare	% 2nd Tare	% Total Tare
SR94	4.0	2.2	6.3
E17	3.1	1.8	4.9
SR95	2.5	1.8	4.3
EL52	1.8	1.4	3.3

EMERGENCE AND STAND ESTABLISHMENT OF SMOOTH ROOT GERMPLASM IN DISEASED AND NON-DISEASED NURSERIES

J. Mitchell McGrath and Tim M. Duckert
USDA - Agricultural Research Service

Seedling emergence and stand establishment continue to be a high priority for growers, and the research activities of the USDA-ARS at East Lansing continue to address this problem. Traditionally, sugar beet breeders have not had tools to select for improved emergence, and although it is apparent that genetic variation exists for enhanced emergence, large environmental influences in both agronomic and seed production fields preclude direct selection for this important character. The basic biology of the seed is such that stored food reserves are limited, and rapid emergence and quick transition to photo-autotrophic growth is imperative. Any useful test to be used for breeding and selection of emergence potential needs to reflect field performance.

This test (01BB03) was conducted to compare emergence and stand establishment among smooth-root (SR) germplasm between the agronomic test in Test 00BB01 and the disease ground directly North of the Saginaw Valley Bean and Beet Research Farm pond. The disease ground has had a long history of failing to support beet growth, and has been used as a test bed for evaluating emergence under diseased conditions for the past four years. All the major seedling pathogens have been recovered from these plots, including Aphanomyces, Rhizoctonia, Pythium, and Phoma.

Each entry was planted with 2 grams of untreated seed on April 19, 2001 and emerged seedlings were counted at 15, 20, and 27 days after planting (DAP). Seedling counts were also taken at 40 and 52 DAP in the disease nursery where plants were not thinned to final stand. Agronomic counts were taken from 01BB01, a six replicate test. Only three replicates were planted in the disease nursery (Test 01BB03). Heavy spring rain prior to the 20 day stand count lead to standing water for seven days in Test 01BB03.

Results in TABLE 1 reflect the actual emergence stand counts for each of the entries in 2001. As each entry had slightly different seed number per planted weight of seed, comparisons between actual numbers should be made cautiously. Also, three entries tested were monogerm, E17, EL 52, and US H20. Multigerm seed has from one to four true seed per seed ball (botanically called a utricle) and all to none may germinate and emerge.

Previous work suggested emergence is affected by poor soil moisture (e.g. abiotic stress), and that this is separate from stand persistence, which appears to relate to biotic stress (e.g. seedling disease). Abiotic stress germination can be done with reasonably high confidence in the laboratory, but the biotic stresses are not as well understood. Although we have a description of the organisms, the mechanisms of disease progression and the progression of disease pressures through the emergence phase of stand establishment need more focus. What is clear is that stand counts drop consistently after some maximum emergence is attained.

Results from the agronomic test (01BB01) shown in TABLE 1 are consistent with observations of stand count reduction, with two interesting exceptions, SR96 and EL52. Their significance is unclear, but a lack of stand reduction (i.e. better persistence) would be one measure of seedling disease resistance. It is unlikely that SR96 and EL52 would show the same level of tolerance to each of the causative seedling disease organisms.

TABLE 1: Actual emerged beet stand count values in the agronomic (Agron., Test 01BB01) and diseased (Diseased, Test 01BB03) nurseries for 12 entries, ranked by 27 DAP Agron. DAP = days after planting.

Entry	15 DAP Agron.	20 DAP Agron.	27 DAP Agron.	15 DAP Diseased	20 DAP Diseased	27 DAP Diseased	40 DAP Diseased	52 DAP Diseased
SR97	46.7	105.8	82.5	36.7	53.3	46.7	33.3	31.7
E17	60.8	86.7	79.2	65.0	88.3	66.7	46.7	41.7
SR87	47.0	81.7	75.0	50.0	78.3	61.7	38.3	38.3
EL50	43.3	80.8	72.5	38.3	58.3	50.0	33.3	30.0
SR95	35.0	80.0	69.2	40.0	68.3	53.3	40.0	35.0
SR96	45.0	69.2	69.2	35.7	50.0	43.3	31.7	30.0
EL52	40.0	65.0	65.0	18.7	31.7	26.7	22.3	24.7
EL0204	46.3	70.0	64.2	33.3	65.0	58.3	33.3	28.3
SR93	41.7	69.2	64.2	41.7	53.3	43.3	30.0	28.3
SR94	48.3	70.0	63.3	35.0	58.3	53.3	33.3	31.7
SR80	38.3	66.7	61.7	24.0	36.7	36.7	28.3	26.7
US H20	30.4	59.0	57.0	46.7	63.3	53.3	40.0	35.0
Mean	43.76	75.56	68.73	38.75	58.75	49.44	34.22	31.78
F value	2.2*	4.5**	3.6**	1.8 ^{ns}	2.1 ^{ns}	1.5 ^{ns}	1.3 ^{ns}	0.8 ^{ns}
LSD $_{(0.05)}$	14.2	16.6	11.1	26	31.7	25.9	16	16.3
CV (%)	30.6	23.6	16.5	44.5	37.3	33.7	29.1	29.3

TABLE 2: Percent of stand counts relative to 27 DAP for each entry in agronomic (Agron.) and diseased (Diseased) nurseries for 12 entries arranged in order of stand at 52 DAP in the disease nursery. DAP = days after planting.

Entry	15 DAP Agron.	20 DAP Agron.	27 DAP Agron.	15 DAP Diseased	20 DAP Diseased	27 DAP Diseased	40 DAP Diseased	52 DAP Diseased
US H20	53.3	103.5	100.0	81.9	111.1	93.6	70.2	61.4
E17	76.8	109.5	100.0	82.1	111.6	84.2	58.9	52.6
SR87	62.7	108.9	100.0	66.7	104.4	82.2	51.1	51.1
SR95	50.6	115.7	100.0	57.8	98.8	77.1	57.8	50.6
SR94	76.3	110.5	100.0	55.3	92.1	84.2	52.6	50.0
EL0204	72.2	109.1	100.0	51.9	101.3	90.9	51.9	44.2
SR93	64.9	107.8	100.0	64.9	83.1	67.5	46.8	44.2
SR96	65.1	100.0	100.0	51.6	72.3	62.7	45.8	43.4
SR80	62.2	108.1	100.0	38.9	59.5	59.5	45.9	43.2
EL50	59.8	111.5	100.0	52.9	80.5	69.0	46.0	41.4
SR97	56.6	128.3	100.0	44.4	64.6	56.6	40.4	38.4
EL52	61.5	100.0	100.0	28.7	48.7	41.0	34.4	37.9
Mean	63.7	109.9	100.0	56.4	85.5	71.9	49.8	46.2

Relative performance of each entry across each nursery and time point is given in TABLE 2, which compares each entries' count to its 27 DAP count in the agronomic trail. These data essentially compare the performance in the agronomic nursery to their persistence in the disease nursery. For the top four entries, early emergence at 15 DAP was higher in the disease nursery than the agronomic nursery, perhaps as the result of better moisture availability, increased 'vigor' of these entries, or better pre-emergence disease resistance. Disease nurseries entries did not persist in the disease nursery at 27 DAP as well as in the agronomic nursery, although two entries were within 10% of the agronomic counts (US H20 and EL0204). Long-term persistence was best with US H20, even though actual emergence of US H20 was relatively poor.

SEED ARCHIVE AND STORAGE ACTIVITIES

J. Mitchell McGrath, Teresa Koppin, and Tim M. Duckert
USDA - Agricultural Research Service

Sugar beet seed storage facilities were updated in 2000. The new facility is a 176 ft^2 walk-in cooler with 435 ft^2 of shelf space. Storage is maintained at 4°C (39.2°F) and 25% relative humidity. We have moved over 15,000 packages of seed from various uncontrolled climates to the new storage facility. As part of this move, we did a field scale germination study of many of the older seed packages. As a result, we discarded over 3,500 seed packages that had no emergence. A database is being built to catalog and track the history of these and future seedlots. Further field tests and genetic evaluation will be done to expand the information included in the database to improve efficiency and accuracy. Organizing, repackaging and physically accounting for all seed has been accomplished in 2001.

Current seed inventory includes: 7,825 crosses (0.1 to 50 g dating from 1985); 1,651 packages with seed listed as mutants, previous releases, or genetic stocks; 69 large seedlots of increases done locally; 277 seedlots of previous ARS germplasm releases, developmental populations, and combining ability populations grown in Oregon; 254 Plant Introductions obtained from the National Plant Germplasm System; and 100 commercial seedlots. All reasonable requests for seed held at East Lansing will be honored.

CONCEPT, DESIGN, AND CONSTRUCTION OF A SUGAR BEET HARVESTER WITH INTEGRATED SINGLE BEET SUCROSE ANALYSIS

J. Mitchell McGrath and Tim M. Duckert
USDA - Agricultural Research Service

Molecular biology is allowing better understanding of the genetic, biochemical, and physiological processes that operate within plant cells and tissues, and with this increased understanding better decisions can be made regarding the improvement of agronomic traits. Generally, molecular biology works best at the single plant level, which creates a problem in transferring this knowledge to a field crop such as sugar beet where most analyses are done on a plot basis and data is collected from numerous plants at once.

We are fabricating of a one-row sugar beet harvester to weigh and determine sucrose concentration for each beet harvested. Our plan is use this capability to evaluate sucrose concentration under varying field conditions and over time. The harvester should also give us the real time data needed to make selection decisions while harvesting both large and small sized plots, as well as the opportunity to screen large amounts of germplasm for the essential trait of sucrose accumulation. It is our intention that this piece of equipment will be in operation by August of 2002.

A list of goals for this machine, ideally, would be a harvester that: (i) is capable of weighing each beet and determining concentration of sucrose and major impurities, (ii) is easily transportable between distant locations, (iii) is modular and adaptable to changes in research needs, (iv) allows for selections to be made with knowledge of specific real time data, (v) makes efficient use of operators time and energy, and (vi) incorporates modern technology into the lifting, cleaning and processing of the beet. Sucrose analysis technologies such as time domain reflectometry, refractometry, and near infra-red spectroscopy will be evaluated.

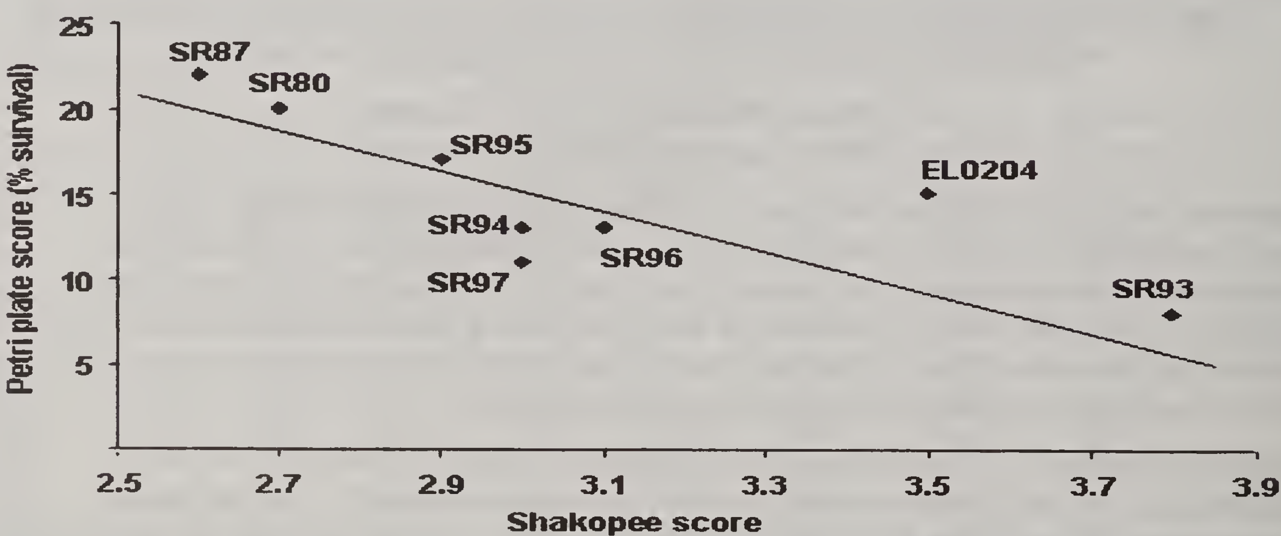
GENETIC ANALYSIS OF APHANOMYCES SEEDLING RESISTANCE

Yi Yu and J. Mitchell McGrath
Michigan State University and USDA - Agricultural Research Service

Aphanomyces seedling disease is one of the causal agents preventing good stand persistence. Aphanomyces generally becomes more of a problem for growers when plants are four to six weeks old, especially after a heavy rain and in flooded areas of the field. Other than selection under infested field conditions, there has been no reliable seedling resistance screen. The major focus of this work has been analyses of Aphanomyces resistance in two- to three-week old seedlings. The major issue has been whether resistance is heritable, and if so, to locate genes that control reaction to Aphanomyces in the genome.

A method was developed for testing seedlings for reaction to Aphanomyces (the method is provided at the end of this section). The major considerations to accept a method were that it: (i) be able to reasonably follow field evaluation scores (FIG. 1), (ii) that it discriminate reactions in a segregating population (FIG. 2), and (iii) that a genetic association be evident between Aphanomyces reaction and at least one molecular marker (FIG. 3). To a first approximation these conditions appear to have been satisfied.

FIGURE 1: Comparison of *in vitro* inoculation with field infestation done at the Betaseed nursery at Shakopee MN using smooth-root germplasm releases.

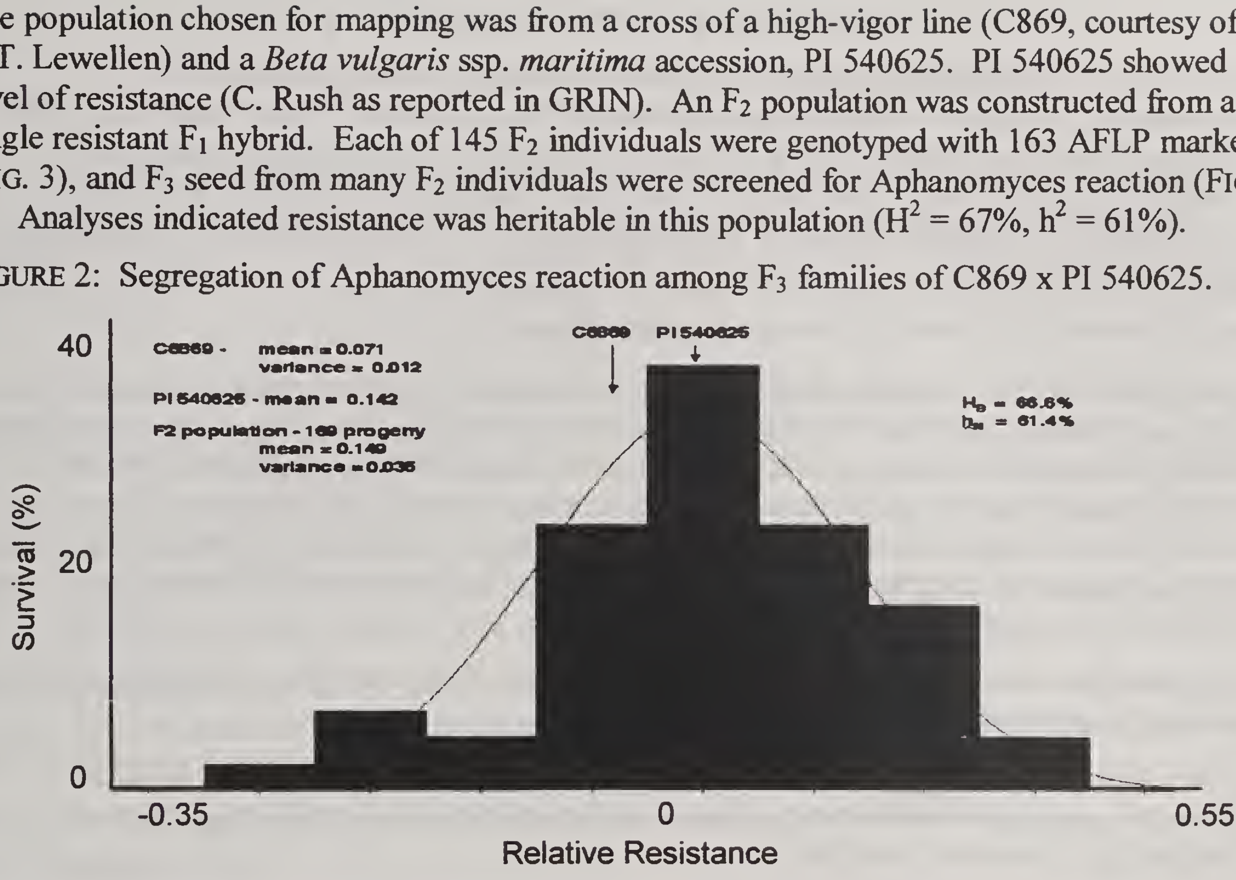


Two of the more important developments for this assay were to minimize zoospores from encysting, and inducing seedling vigor with hydrogen peroxide during germination. After germination, seedlings were grown in shallow water to maintain a flooding-like stress, and roots and hypocotyls were briefly bathed with a zoospore suspension. Infection was scored on appearance of hypocotyls after three to five days, with brown, water-soaked lesions indicating a severe infection.

Results of comparing box inoculation with field results at Shakopee showed an acceptable negative correlation (r = -0.79; Fig. 1). The correlation is negative because the box inoculation measures survival and the field scores indicate the extent of damage.

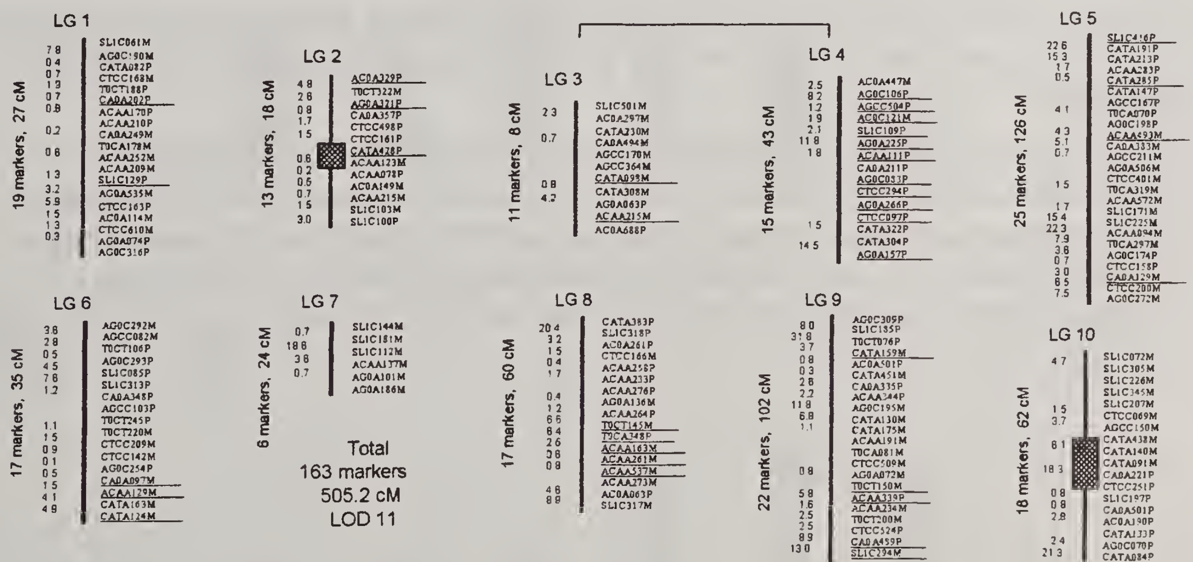
The population chosen for mapping was from a cross of a high-vigor line (C869, courtesy of R.T. Lewellen) and a *Beta vulgaris* ssp. *maritima* accession, PI 540625. PI 540625 showed high level of resistance (C. Rush as reported in GRIN). An F_2 population was constructed from a single resistant F_1 hybrid. Each of 145 F_2 individuals were genotyped with 163 AFLP markers (FIG. 3), and F_3 seed from many F_2 individuals were screened for Aphanomyces reaction (FIG. 2). Analyses indicated resistance was heritable in this population ($H^2 = 67\%$, $h^2 = 61\%$).

FIGURE 2: Segregation of Aphanomyces reaction among F_3 families of C869 x PI 540625.



QTL analyses showed that two or three loci contribute to resistance in this population (FIG. 3). Two well supported loci on linkage groups (LG) 2 and 10 are shown. LG6 has a potential third locus. It should be noted that our linkage group numbering is not anchored to other maps.

FIGURE 3: Quantitative Trait Loci (QTL) analyses show linkage of Aphanomyces resistance on LG 2 and LG 10, explaining 19% and 36% of variance, respectively. LG3 and LG4 are linked at lower LOD threshholds.



Aphanomyces inoculation protocol

Soak seeds for 6 to 10 hrs in 0.3% peroxide before sterilization, which has improved germination. Surface sterilize the seeds by using 15% Clorox for 20 min, wash with sterile distilled water three times. Place seeds on wet filter paper in Petri dishes to germinate. Cover seeds to half-height with water. Check and change water frequently to minimize contamination. Contaminated seeds or seedlings should be removed immediately, replace filter paper as necessary.

Two-to-three week old seedlings were used in inoculation.

Prepare inoculum. One week after seed germination, transfer Aphanomyces mycelium blocks (from agar plate) into CMA liquid solution (Corn meal agar, Sigma, 17g / L, filter and retain liquid part, autoclave 15 min). Grow fungus in the dark at room temperature. One day before inoculation, wash mycelia in the liquid culture three times with sterile Millipore water. The mycelia are then cultured in the proper amount of Millipore water (1/3 to 1/2 the original volume of CMA solution used) for one day or less in the dark. This step will force mycelia to generate zoospores.

Estimate zoospore concentration using a haemocytometer. Dilute to a final concentration of 200 zoospores / ml for inoculation.

Each Petri dish will have about 20 plants. Decant original culture water. Shake inoculum frequently, and dispense zoospore solution to submerge roots (about 20 ml). An even distribution of inoculum is critical.

Incubate plants in the dark for 1 to 1.5 hours at room temperature. Decant inoculum, rinse plates briefly with Millipore water (15 to 20 ml), decant, and pour fresh water (ca 15ml) to each plate to keep roots covered. Grow plants under light and high humidity.

Record survivors each day beginning on the third day.

Notes:

1. In place of Petri dishes, inoculations in Rubbermaid plastic boxes (9"x6"x2") with as many as 60 plants per box have worked well. Solution volumes need to be adjusted accordingly.
2. One variation that has not been tested is to suspend inoculum in 15 to 20% PEG (Molecular weight 3,350, Sigma P4338) to get final concentration of 2000 zoospores / ml PEG solution, then dispense 2ml solution to each dish (final zoospore concentration remains the same, i.e. 200 zoospores / ml). This may give a better distribution of zoospores, but the incubation (with zoospores) time may be longer, e.g. 1.5 to 2 hours.

UPDATE: GERMINATION IN AQUEOUS SOLUTIONS

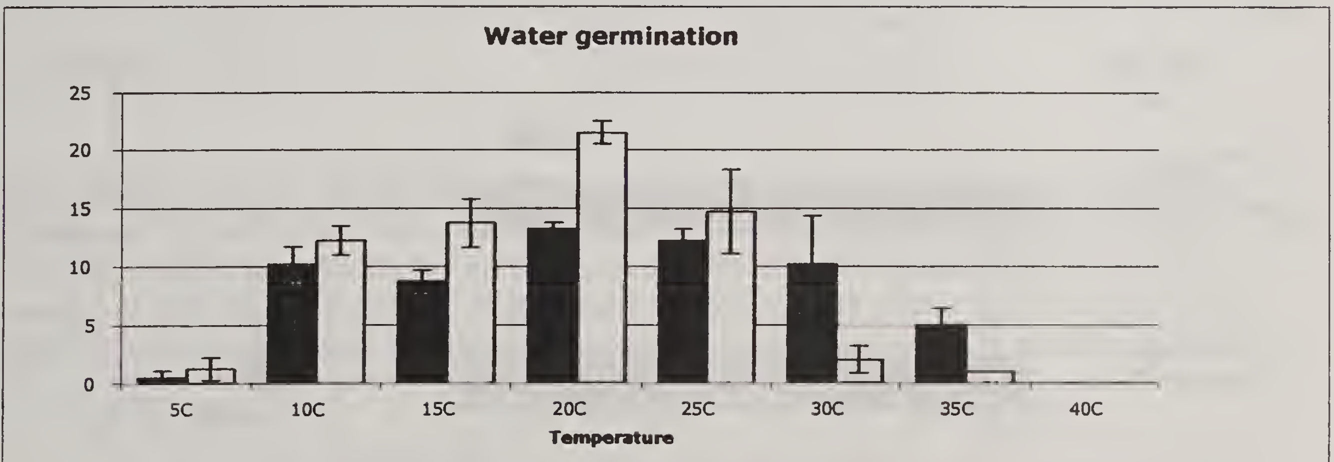
David Moldovan, R. Scott Shaw, and J. Mitchell McGrath
USDA - Agricultural Research Service

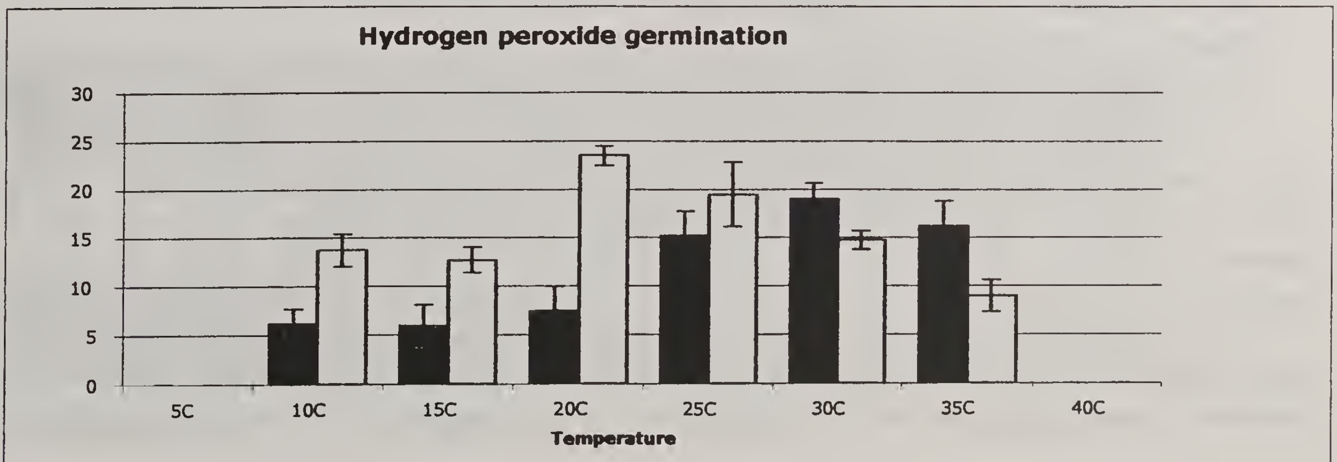
We have shown that germination in aqueous solutions is a reasonable predictor of seedlot field emergence, and have used this approach to clone a gene that appears to be responsible for enhanced emergence. We have followed these experiments, previously done only at room temperature (23°C = 73°F), to look at germination at different temperatures between a vigorous hybrid, US H20, and one that has less vigor, ACH 185.

Seeds (4 replicates of 25 seed) were germinated in 20 ml of either water (18 MOhm purified) or hydrogen peroxide (0.3%), at a range of temperatures (FIG. 1). Maximum germination of both varieties in water was at 20°C (68°F), and US H20 germinated to a greater extent than ACH185 at temperatures 25°C (77°F) and lower in both water and hydrogen peroxide. Interestingly, ACH185 was better at germinating at temperatures of 30°C (86°F) and above (no germination was seen at 40°C = 104°F). Hydrogen peroxide was detrimental at 5°C (41°F) but little germination had occurred, and had little effect at 10°C (50°F) or 15°C (59°F).

In hydrogen peroxide, ACH185 showed the greatest germination at 30°C. We conclude that germination under stress is highly temperature dependent, and that variability exists for low and high temperature germination optima.

FIGURE 1: Germination in solution of high and low emergers at different temperatures in water vs hydrogen peroxide.





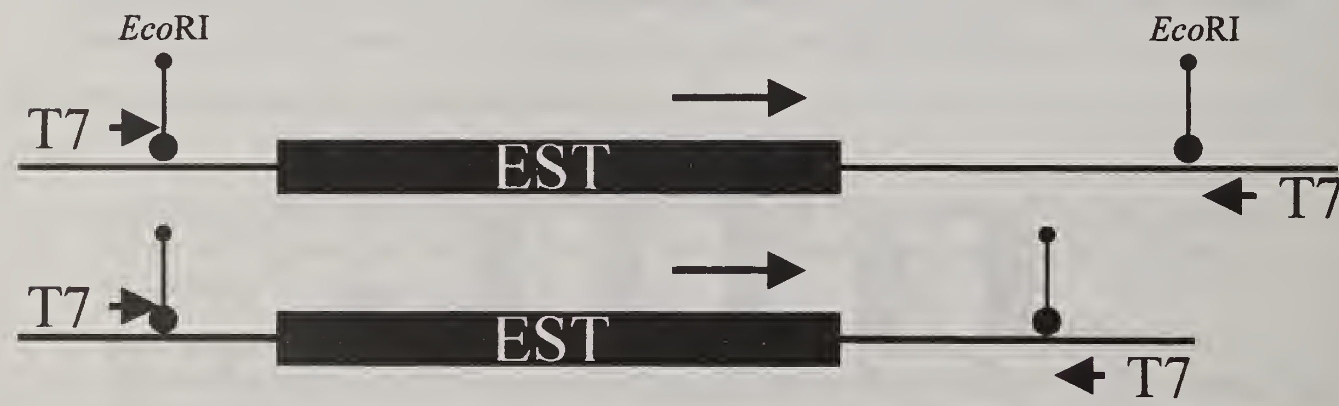
USING EST SEQUENCES AS GENETIC MARKERS IN SUGAR BEET (EST-UTR)

J. Mitchell McGrath and R. Scott Shaw
USDA - Agricultural Research Service

Public plant breeding programs typically are resource limited for the breadth of field, greenhouse, and laboratory tasks required for success. Full genomics programs are unlikely to occur for minor crops in the foreseeable future, yet the wealth of genomic information available could be utilized if simple and cost effective strategies could capitalize on combining gene expression (ontogeny) with trait inheritance (phylogeny). One approach is to use ESTs (Expressed Sequence Tags, the actual products encoded by genes) to locate genes to linkage groups, as a first step in co-locating Quantitative Trait Loci within gene-rich regions. In sugar beet, we have not yet had the resources to develop enough sequence information for SNP (single nucleotide polymorphisms; a rapid, abundant, and inexpensive marker resource) discovery, yet the 2,500 ESTs available are sufficient to serve as genetic markers. Rather than design primers to amplify each EST separately and individually, we report here the results of our efforts to streamline the process by developing amplicons that can then be queried using a single primer derived from an EST. Sequentially amplifying amplicons with different EST primers should allow more efficient use of limited resources.

The following figures demonstrate the practicality of this approach, and highlight some of the considerations in its practice.

FIGURE 1: Schematic of strategy to use ESTs as anchors to uncover length polymorphisms. Arrows indicate primer binding sites, barbells indicate restriction endonuclease enzyme cleavage sites.



Adaptor Sequences used: T7 adaptor primer = $^{5'}$TAATACGACTCACTATAGGG$^{3'}$
Adaptor: $^{5'}$TAATACGACTCACTATAGGGCT$^{3'}$
Adaptor complementary strand: *Eco*RI $^{5'}$AATTAGCCCTA$^{3'}$, *Mse*I $^{5'}$TAAGCCCTA$^{3'}$, *Msp*I / *Hpa*II $^{5'}$CGGAGCCCTA$^{3'}$, *Sau*3A $^{5'}$GATCAGCCCTA$^{3'}$, Blunt end $^{5'}$AGCCCTATAG$^{3'}$

DNA from sugar beet leaves was digested using one of six restriction enzymes: *Eco*RI, *Dra*I, *Sau*3A, *Mse*I, *Msp*I, or *Hpa*II. Adaptors, which include a T7 reverse primer sequence, were ligated to restriction fragments, and amplified *en mass* to produce amplicons. EST-specific primers (27 to 30bp in length; T_m 58 to 61°C; GC content ca. 50%), oriented towards either the 3' (or 5') untranslated regions, were created from target ESTs (genes) of interest. In combination with the amplicon specific primer (T7), EST fragments amplified represent sequences between the gene and a restriction site. In this instance, PCR products were detected

using 6% polyacrylamide(or 1% agarose) gels that revealed length differences, although in theory heteroduplex analyses could also be performed.

Gene Specific Primer Design: Sugarbeet ESTs (from GenBank; http://www.ncbi.nlm.gov) with similarity to Arabidopsis genes (e-value 10^{-15} or better), for a first approximation, were aligned using *Biotechnix 3D* (Gentech) analysis software. Regions of highest similarity were targeted for EST-specific primers.

TABLE 1: List of ESTs tested and their putative function determined through similarity searching of GenBank databases.

NCBI EST#	Primer	Putative Gene Function
BI543344	RSS2	isocitrate lyase
na	RSS7	glyceraldehyde 3-phosphate dehydrogenase
na	RSS8	unidentified
BI096311	FP1	s-adenosylmethionine synthetase
BI096185	FP2	fructose bisphosphate aldolase
BI543691	FP3	calmodulin
BI543416	FP4	glyceraldeyde-3-phosphate dehydrogenase
BI543480	FP5	adenosylhomocysteinase
BI095989	FP6	ribulose bisphosphate carboxylase, small subunit
AF310016	FP11	germin - BvGer non-specific
AF310016	FP13	germin - BvGer165-specific

FIGURE 3: EST-specific amplification from amplicons using Primer RSS7, visualized on an agarose gel stained with ethidium bromide. From this gel, amplicons ranged in size up to 4 kb in *Eco*RI adapted amplicons, but no EST specific bands were seen in the *Eco*RI or *Mse*I amplicons with this EST primer. EST primed fragments were visible with both *Msp*I and *Hpa*II amplicons, and were identifiable through the background of T7 primed amplicons.

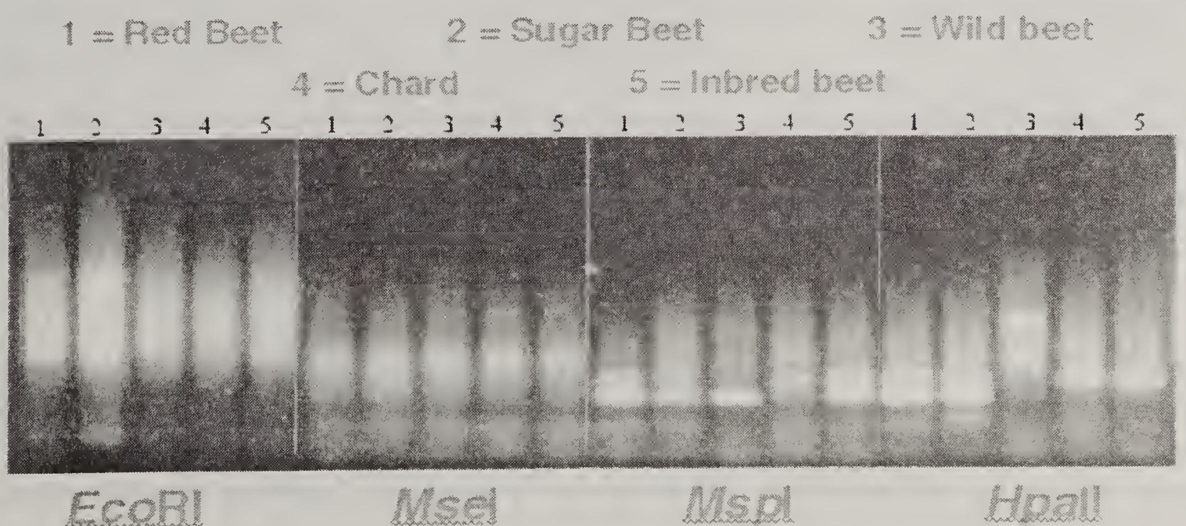


FIGURE 4: Detection of segregating RSS2 (isocitrate lyase) polymorphisms in 15 individuals from a sugar x red beet (C869 x W357B) F_2 population, using three restriction enzyme (left to right = *Msp*I, *Sau*3A, and *Eco*RI). No polymorphism is seen with the RSS2-*Msp*I combination, but polymorphism is evident with the other two.

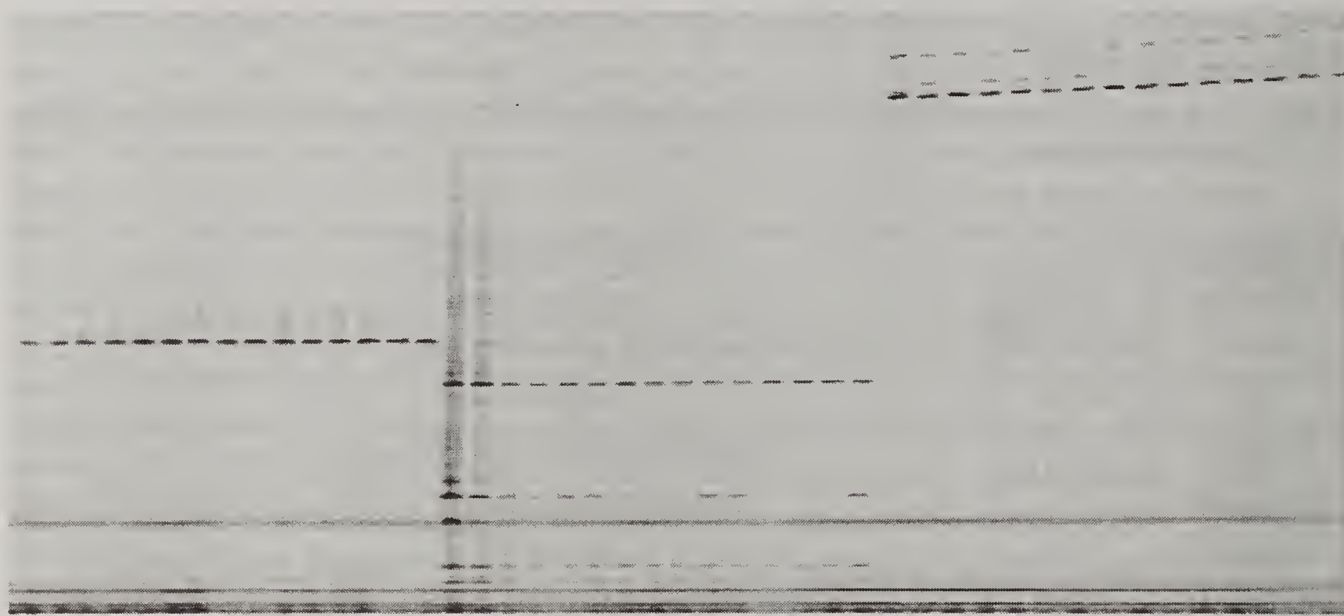
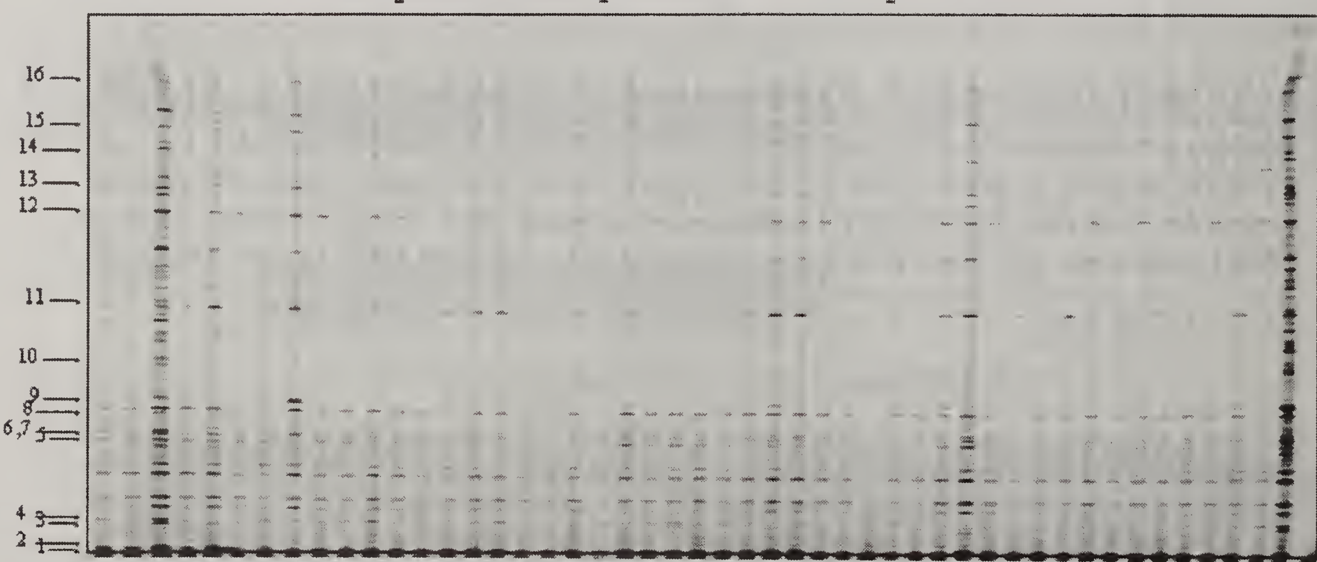


FIGURE 5: Complex segregation pattern in the C869 x W357B F_2 population using *Eco*RI amplicon and EST primer FP3 (calmodulin). Sixteen loci were evaluated for segregation. Twelve of the 16 scored polymorphisms segregated with Mendelian expectations.

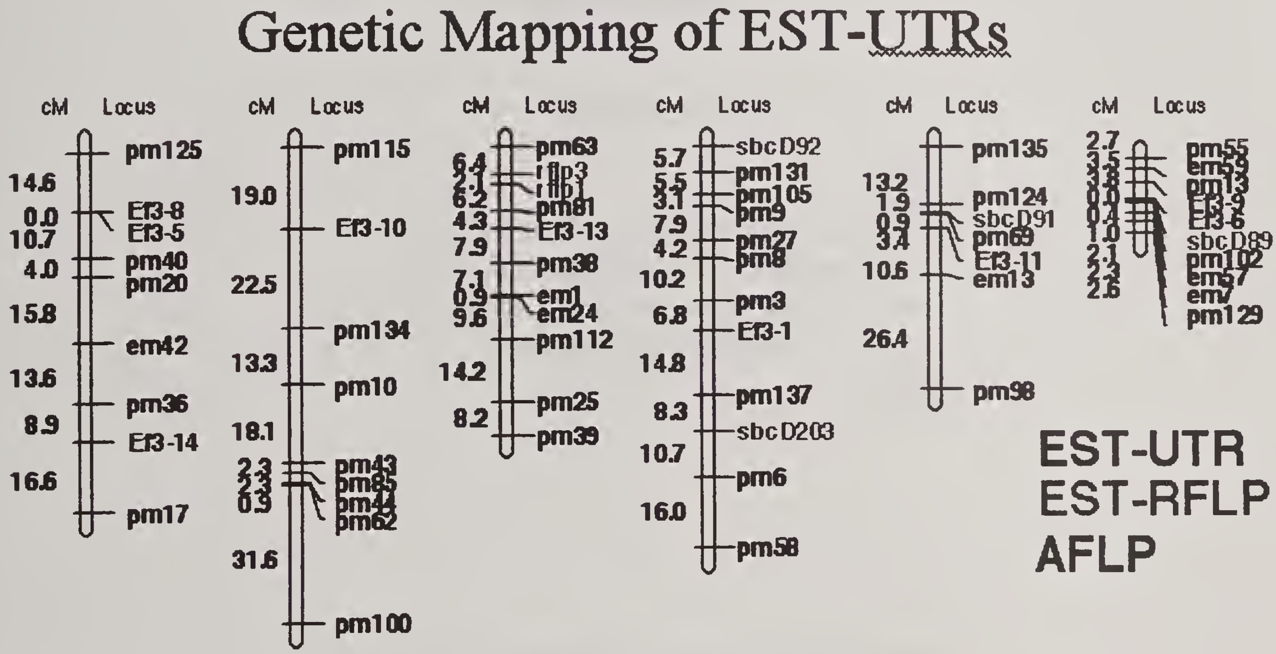


Results suggest that a restriction enzyme x EST primer combination can be useful for detecting segregation at actively expressed genes, and that in beet, a reasonable level of polymorphism can be expected. Across 18 restriction enzyme x EST combinations tested to date, only three have failed to show at least on polymorphism. Of the one to 16 amplified fragments detected in each

of the 15 polymorphic combinations, the proportional number of polymorphic bands ranged from 10% to 100%.

In order to ascertain linkage with other molecular markers, segregation was compared with Amplified Fragment Length Polymorphism (AFLP, designated with prefix em or pm in Figure 6)) markers and with Restriction Fragment Length Polymorphisms (RFLP, designated with rflp or sbc) in the sugar x red beet segregating population. Nine of the polymorphisms in Figure 5 were linked with these other types of markers on six of the nine beet linkage groups.

FIGURE 6: Linkage of EST-UTR markers with AFLPs and RFLPs.



We conclude that EST-UTR reveals polymorphisms and these polymorphisms can be genetically mapped. Further, the protocols are relatively straightforward and amenable to high-throughput operations. Thus, ESTs can be used as a ready source of PCR-competent genetic markers in virtually any species. In the future, EST primer design and choice of restriction enzyme appear to be most critical for ensuring success, as only 35% of the EST primers chosen have successfully amplified a detectable fragment.

The authors thank Cato *et al.* (2001) A rapid PCR-based method for genetically mapping ESTs. Theoretical and Applied Genetics 102: 296-306.

SUGAR BEET RESEARCH

2001 REPORT

Section F

Molecular Plant Pathology Laboratory
Agricultural Research Service
United States Department of Agriculture
Beltsville, Maryland

Dr. Ann C. Smigocki, Research Geneticist
Dr. David Kuykendall, Plant Pathologist
Dr. Chris Wozniak, Visiting Scientist

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Gene Transfer to Improve Sucrose Yields from Sugar beet Taproots

BSDF Project 810

Ann C. Smigocki and Snezana D. Ivic

Introduction

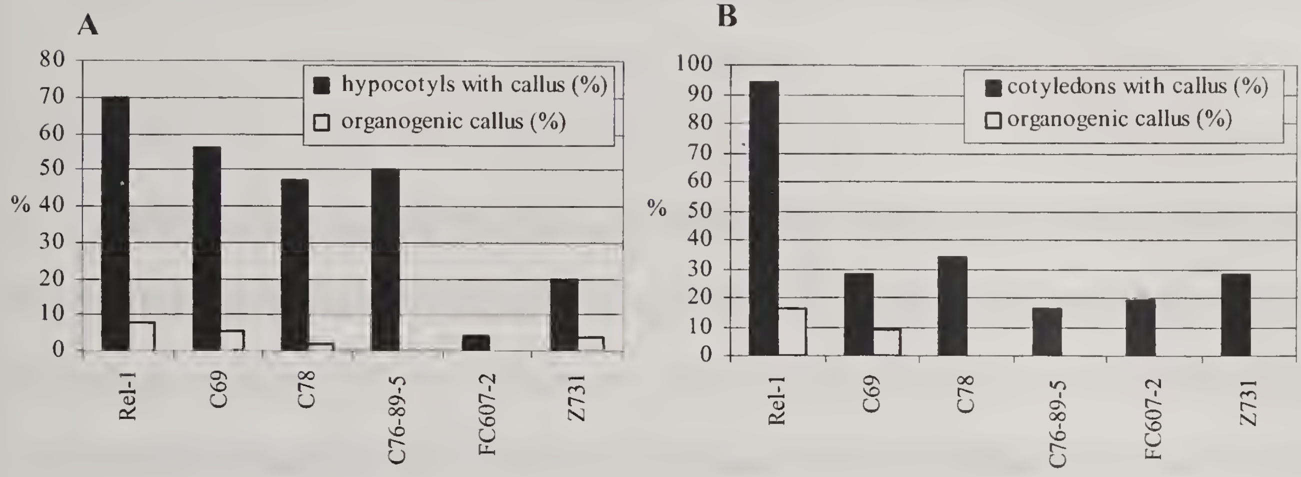
We regenerated transgenic sugar beets that were engineered to produce increased levels of the plant growth hormone cytokinin in the taproots in order to evaluate the effect of cytokinin on rate of cell division, vascular ring development, and sucrose accumulation in the taproots (Ivic et al., 2001b; Snyder et al., 1999). Initiation of cambia and rapid cell expansion and division have been reported to be correlated with changes in hormonal concentrations in the developing taproot (Elliot and Weston, 1993). In addition, cytokinins have been identified as having functional significance in the control of assimilate movement in plants, particularly by altering phloem unloading, sink initiation, and sink strength and capacity. To increase the endogenous cytokinin concentrations in the taproot, we fused the bacterial cytokinin biosynthesis gene, *ipt*, to a tuber-specific promoter from the patatin gene of potato. The transgenic shoots we regenerated had to be cultured on media with high auxin concentrations to promote root development in order to compensate for the elevated cytokinin levels. Greenhouse grown plants exhibited growth characteristics associated with elevated cytokinin concentrations that included more prolific development of adventitious shoots, reduced apical dominance, dark green leaves or fewer and smaller leaves. Analysis of sucrose concentrations in transgenic plants revealed that the leaf sucrose levels were comparable to those in normal controls. The taproots of transgenic plants had low sucrose concentrations in comparison to the controls because the taproots did not develop normally and their weight was reduced by over 90%.

Progress Report

The effects on photosynthesis and assimilate partitioning that are induced by changes in the endogenous cytokinin content due to the expression of a cytokinin biosynthesis gene have not been studied extensively. We successfully regenerated three transgenic shoots for analysis of cytokinin effects on taproot development and sucrose accumulation. However, a larger number of independent transformants is needed to evaluate the role of cytokinins in photosynthate accumulation and taproot development in sugar beet. Regeneration of transgenic plants is dependent on the availability of an efficient transformation method that currently is lacking for sugar beet.

The particle bombardment transformation method developed in this laboratory and used to generate the transgenic sugar beet for this study relies on the use of embryogenic hypocotyl callus produced from a tissue culture clone, REL-1, that was originally selected for its high regeneration potential *in vitro* (Saunders, 1998; Snyder et al. 1999). REL-1, however, is not a suitable breeding line for rapid genetic improvement of commercially important sugar beet lines. Therefore, we tested the feasibility of using the particle bombardment transformation method with the following commercially important breeding lines, C69, C78, C76-89-5, FC706-2 and Z731 (Ivic and Smigocki, 2001).

Breeding line C69 proved to be a good source for production of embryogenic hypocotyl callus that was similar to the callus produced by the REL-1 clone. In addition, cotyledons of both the REL-1 and C69 lines produced callus that regenerated shoots at similar rates. A number of shoots were regenerated and shown by PCR to contain the introduced *ipt* gene as well as the selectable marker gene *npt II*. Transgenic shoots did not develop into normal plants as tissue culture propagation induced vitrification that inhibited further development of the shoots.



The particle bombardment method is a lengthy protocol that requires a 3-week seed germination period followed by a hypocotyl and cotyledon cultivation period of 6 to 8 weeks. The method is also hampered by low seed germination frequencies, persistent fungal contamination, time consuming hypocotyl and cotyledon excisions, and overall low quantities of embryogenic callus that is generated. We, therefore, explored the use of different plant tissue as a source of embryogenic callus to use for transformation experiments.

We analyzed leaf explants from breeding lines FC 607, C69, C78, C76895, 7911-4-10 and Z731 for their callus forming ability and shoot regeneration potential (Ivic et al., 2001a). Line FC607 was equal to the REL-1 clone in its ability to form regenerative callus. More than 75% of the leaf discs formed friable callus with more than half regenerating an average of 10 shoots per leaf disc. Preparation of suspension cultures from the leaf disc callus generated large quantities of embryogenic callus for use with the particle bombardment transformation method. The advantages of using leaf discs instead of hypocotyls or cotyledons for production of the

callus include minimal contamination rates in tissue culture, ease of handling of the plant material, and relatively large quantities of callus that can be generated in a short period of time.

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Engineering sugar beet root maggot resistance with multiple proteinase inhibitor genes

BSDF Project 811

Ann C. Smigocki

Introduction

The sugar beet root maggot, *Tetanops myopaeformis* Roder, is a major sugar beet pest of the central and western sugar beet-growing areas in the United States and Canada. More than half of the1.5 million U.S. acres of sugar beet grown annually are infested with the root maggot and nearly all acreage is subject to damage in Canada. As the developing maggot larvae feed on roots throughout the growing season, significant crop damage and yield losses that average about 23% are inflicted. Applications of carbamate or organophosphate classes of pesticides are primarily used to reduce larval populations but control is often inconsistent. The lack of effective control measures that do not rely on broad-spectrum insecticides has hastened the search for alternate approaches such as biocontrol and genetic engineering.

Potent proteinase inhibitors that target the digestive enzymes of insect pests have been found to occur naturally in a number of plant species. It is speculated that in some cases these inhibitors may be part of the plant's natural defense arsenal for combating insect predators. In laboratory experiments where proteinase inhibitors were incorporated into insect diets, a combination of inhibitors were found to be more toxic at levels where individual inhibitors were not effective. In addition, higher levels of more than one proteinase inhibitor have been found in insect resistant vs. susceptible plants. These results suggest that genetic engineering of plants with multiple classes of proteinase inhibitor genes against individual proteolytic activities in the insect gut will likely be an effective strategy for insect control.

In order to devise a rational control strategy using proteinase inhibitors, it is necessary to first determine the specific digestive enzymes of the targeted pest as significant variations exist in the types and properties of digestive enzymes utilized by insects. The physiological or biochemical nature of the root maggot midgut proteases was not known. Therefore, we characterized the major midgut proteases in feeding second instars collected from infested fields in Minnesota (Wilhite et al., 2000). Midgut extracts were prepared within 48 hours from time of collection and analyzed for protease activities at a range of acidic to basic pHs using commercial biochemical inhibitors and several plant proteinase inhibitors that target the three major mechanistic classes of endoproteinases: aspartyl, cysteine and serine. We determined that a majority of the digestive enzymes found in the actively feeding maggot midguts are aspartyl and serine proteases and that only a relatively small portion of the activity is associated with cysteine proteases. Our results are consistent with what has been reported in other Dipteran insects although for most only a single major protease was reported.

In vitro inhibition of midgut activity with a single proteinase inhibitor will not necessarily inhibit digestion as some insects seem to be physiologically capable of avoiding toxicity due to protease inhibitor ingestion by secreting "inhibitor-insensitive" enzymes and by the proteolysis of proteinase inhibitors by non-target digestive proteases. We propose to combine inhibitors effective against all the major proteolytic activities of the root maggot as a strategy for enhanced stability and additive effect on proteolytic inhibition that was not tested by us *in vitro* with the maggot extracts because of the differing pHs at which each proteolytic activity was found. Based on our results, we anticipate that combining the strongest inhibitors for serine and aspartyl proteinases would be expected to yield better control than the use of either inhibitor alone and that addition of cysteine protease would strengthen the effect.

Progress report

One of our main objectives is to develop transgenic sugarbeet that are resistant to the root maggot using proteinase inhibitor genes that specifically target the digestive enzymes of the maggot. Taproot-specific expression of genes coding for the aspartyl, serine and cysteine proteinase inhibitors would target the production of the inhibitors to the site of insect attack. We are developing root maggot feeding bioassays using maggot resistant and susceptible sugar beet seedlings to further test the combined effect of the proteinase inhibitors *in vitro* and *in vivo*. Our preliminary results indicate that neonate root maggot larvae will feed on seedlings *in vitro* using the bioassay we have developed (Smigocki and Boetel, unpublished).

We plan to transform sugar beet and other model plants in the *Chenopodiaceae* family with the squash aspartyl, *N. alata* serine, and the rice cysteine proteinase inhibitor genes. We propose to reconstruct the genes for constitutive (potato *ubi*7 gene promoter), wound-inducible (potato proteinase II promoter) and root-specific (patatin gene promoter) over-expression and suppression. The patatin gene promoter is expressed in potato tubers at levels that are up to 1000 times higher than in the leaf or stem and is also induced by high sucrose concentrations. Since the carbohydrate storage cells in both the tuber and taproot are parenchyma cells, we anticipate high level of expression in the sugar beet taproot. The inhibitor genes will be introduced individually and in different combinations in order to pyramid the effect of the inhibitors.

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Cercospora Resistance Bioengineering

L.David Kuykendall, Tammy M. Stockett and Joe Saunders
Molecular Plant Pathology Lab, Beltsville, MD 20705 USA

Introduction

Our research is focused on the construction of transgenic sugar beets that safely control crop losses due to fungal disease. Bioengineering is needed for the control of leafspot disease in sugar beets since germplasm screening and selective breeding have yielded only moderate resistance that is multigenic and not readily incorporated into commercial germplasm. Sugar beet plants survive microbial infection but tonnage and sucrose percentage are significantly diminished. Development of *Cercospora* leafspot disease-resistant sugar beet germplasm could increase crop profitability an overall 20%. Although fungicides are still being used to combat epidemics of foliar disease, this practice unfortunately selects for mutants of the virulent pathogen with newly acquired fungicide resistance. The appearance of new fungicide-tolerant strains of *Cercospora* diminishes the effectiveness of chemical fungicide spraying to control foliar leafspot disease.

In 1999, Snyder, Ingersol, Smigocki & Owens reported the development of transgenic sugar beets carrying genes encoding pathogen defense-related proteins under transcriptional control of stress or wound-inducible promoters. These novel plant genotypes were examined for their ability to inhibit *Cercospora* (Kuykendall and Smigoki, 1999). Two promising transgenic sugar beet genotypes, OOT and *osm*PrS, with antimicrobials under the control of the strong osmotin promoter, were examined in the growth chamber for *Cercospora* leafspot resistance and they were significantly more susceptible than their Rel-1 parental germplasm from which they had earlier been derived (Kuykendall, 2001).

The concept that a pathogen's gene encoding a toxin pump can confer resistance in the host is new. The *cfp* gene, which specifies a cercosporin export protein, has preliminarily been used to create transgenic tobacco highly resistant to infection (R. G. Upchurch, personal communication). The *cfp* gene from one of the *Cercospora* that cause purple stain of soybean was isolated by Dr. R.G. Upchurch, ARS/USDA, NCSU, Raleigh, N.C., who generously supplied it to us. In this report we describe preliminary success in experimentally constructing *cfp*-carrying transgenic sugar beet plants. The success of this particular project has been largely possible due to our recent development of an improved sugar beet regeneration technique (Saunders et al., 2001).

Materials and Methods

Seeds of the C69 breeding line developed by Dr. Bob Lewellen at Salinas, CA, and the Rel-1 biotechnology clone developed at MSU were the starting materials. Seeds were surface sterilized with a standard solution of 15% (v/v) commercial hypochlorite and 0.01% SDS for two washes each 20 minutes followed by 5 rinses with sterile. Seeds were allowed to dry in sterile Petri dishes then placed individually into small Petri dishes containing 5% Trypticase Soy Agar medium (1/20 TSA) and germinated in the dark. The lack of microbial growth ensured sterility of the plant material. After germination the cotyledons were excised and placed on MS medium plates containing 1mg/L BAP. The cotyledons were repeatedly wounded using an 18g hypodermic needle and then swabbed with a cotton applicator soaked in bacterial strain EHA105 which had infected by electroporation with a pBIN19 vector plasmid carrying the *cfp* gene. The infected cotyledons are co-incubated at 30°C in the dark for about 5 days $\pm$ 1 day. Infected

cotyledons are then moved to selective media containing BAP (1mg/L), kanamycin and cefotaxime. Selective plates were placed in low light and room temperature conditions such as those we had earlier determined (Saunders et al., 2001) to produce adventitious shoot regeneration without an intermediate of hormone-independent callus. Transformed cells with the selective marker gene survive selection and some formed shoots. Cotyledons require transfer to fresh selective plates as neighboring cotyledons turn black and leach phenolics, plates dry out, or as antibiotics lose effectiveness with incubations of more than two weeks. Shoots formed on selective medium are routinely transferred to new plates. Leaf tissue samples were used to obtain DNA for PCR verification. PCR products are being sequenced for certainty. Plants that test positive were propagated and re-tested for verification. It is planned that plants from these experiments will be used for *Cercospora* testing in a growth chamber environment.

Transgenic sugar beet genotypes exhibiting *Cercospora* tolerance will be examined for expression of *cfp* immunologically using antibody specific for the CFP protein.

Results

In order to obtain *cfp*-carrying transgenic sugar beets that may effectively resist *Cercospora* leafspot disease, we have treated hundreds of cotyledons of different genotypes treated with bacteria bioengineered to transfer desired genes into plants. About 1% regeneration has been observed, and thus we obtained 3 distinct *cfp*-carrying transgenics, one from Rel-1 and two from C-69 material. These clones are now being propagated to obtain material for gene expression analysis and leafspot susceptibility testing. More transformed plants are also being obtained. Thus we envision that the successful introduction of the *cfp* gene into sugar beet via transformation will likely lead to the identification of germplasm with increased resistance to *Cercospora* leafspot infection. If successful, the resultant germplasm could be used in commercial breeding programs as a source of a single dominant leafspot resistance allelle.

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Acknowledgment

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Characterization of a Fungal Pathogen of the Sugarbeet Root Maggot
BSDF Project 850
Chris A. Wozniak and Ann C. Smigocki

The sugarbeet root maggot, *Tetanops myopaeformis* Röder, remains the most devastating sugarbeet pest in North America. While assessing exact costs of losses are difficult, estimates indicate that millions of dollars ($ US) / season are foregone despite the use of granular and liquid insecticide applications. Organophosphate and carbamate insecticides applied at planting or as over-the-top sprays for adult flies prior to oviposition have offered economically feasible control in many instances, but losses are still problematic in some situations. An ongoing reassessment of the risks associated with the uses of these conventional pesticides, as mandated by the Food Quality Protection Act, may ultimately impact the availability of these products.

Alternatives to conventional chemical controls are currently not available for SBRM management with respect to genetic resistance or biological control agents, although great strides are being made in both areas. At least four laboratories are working toward development and testing of biological agents targeting the SBRM. This includes the USDA-ARS Sugarbeet and Potato Research Unit at Fargo, the Department of Entomology at North Dakota State University, the Pest Management Research Unit at Sydney, Montana, and our efforts in the Molecular Plant Pathology Laboratory at Beltsville. In addition, two commercial interests have requested cultures or further information through material transfer agreements regarding the utility of *Syngliocladium tetanopsis*, a fungus being evaluated for SBRM management.

While employed with the USDA-ARS Sugarbeet Research Unit at Fargo, CAW conducted surveys of microbes associated with the SBRM in the Red River Valley (RRV) of Minnesota and North Dakota. Following the discovery of *Syngliocladium tetanopsis* (Hodge *et al.*, 1998), a new fungal species found to be pathogenic to SBRM larvae and adults, a concerted effort was made to determine the biological plausibility of using this species for inundative or inoculative release into sugarbeet production areas. Specimens were isolated from larval SBRM cadavers from several locations around the RRV and identified as conspecific.

Following the associated requirements of the Budapest Treaty, after issuance of a U.S. patent in 1999, three strains of *S. tetanopsis* were deposited in the Northern Regional Research Laboratory (NRRL) of the USDA-ARS (NRRL 21853, 21854, 30031), and identical cultures also deposited into the USDA-ARS Entomopathogenic Fungi collection at Ithaca, NY (ARSEF 4972, 5497, 5577).

We have determined that all isolates (> 40) collected are infective toward SBRM third instar larvae. A few of these isolates have also been tested on first instar larvae and found to be highly virulent. In fact sporulation commenced on first instar cadavers within 6 days of inoculation with conidiospores in some experiments. Mortality has reached 96 % (n = 120) with some isolates in bioassays of third instar SBRM and 100 % with first instars (n = 40). Isolates have been noted, however, to differ markedly in colony morphology and coloration.

Current objectives for research on this agent include the refinement of culture conditions to enhance the rate and quantity of spore production and to assess the viability of spore preparations through fluorescent cellular probes.

After comparisons of many media (*e.g.*, egg-yolk agar, V-8 agar, PDA, clarified oatmeal agar), culturing of the fungus has been on a modified oatmeal medium (OatM) wherein olive oil and cholesterol have been added to increase the lipid content. With most isolates spore yield is high on this medium, however, time to sporulation varies from as little as 14 days to over 6 weeks. Amendments containing organic nitrogen, such as casein hydrolysate, yeast extract, dried milk, tryptone, or peptone, were added to OatM to enhance growth rate. All sources of nitrogen resulted in a more rapid rate of early hyphal growth, however, sporulation was significantly delayed as compared to OatM.

Liquid shake cultures of *S. tetanopsis* that were initiated in soy and beef protein digests were determined to be a means of rapid mycelial production, however, their use as inoculum onto solid substrates, such as grain (*i.e.*, barley, rice) or an agar-based medium, did not result in rapidly sporulating cultures suitable for increase of a biopesticide. Interestingly though, mycelial cultures of *S. tetanopsis* have remained viable in stationary broth of beef protein digest with yeast extract for over 3 years at ambient temperature. Transfer of conidiospores in liquid diluent (*e.g.*, normal saline) has been used to transfer and increase spore loads for experimentation.

To further define the growth medium for growth and sporulation of *S. tetanopsis*, pH was modified prior to autoclaving. Adjustments to the pH of the OatM medium were achieved with glycine (pH 4.6), MES (pH 5.6), MOPS (pH 6.6), or HEPES (pH 7.6); all buffering agents at 22mM. Comparisons were made to unmodified OatM (pH 6.8). Conidiospores were plated at 1.0×10^5 spores / plate in normal *saline* and incubated at 23°C under diffuse fluorescent lighting with a 12h photoperiod. All media formulations yielded spore germination within 9 days of plating, however, OatM media amended with MES provided for the best overall hyphal growth in the first three weeks of the experiment. Growth on glycine (pH 4.6) and HEPES (pH 7.6) amended media were dramatically reduced as compared to all other media. Sporulation commenced on OatM/MES and OatM by three weeks and differentiation of aerial mycelia was evident. Production of a characteristic sienna-ochre pigment by this fungus was most notable in these same media, suggesting that development and differentiation of sporulating structures (synnemata, simple conidiophores) was progressing most rapidly on these two media. Comparisons performed at 6 weeks of incubation indicated similar growth and development among OatM/MES, OatM/MOPS and OatM media, while the media containing glycine or HEPES showed poor colony growth and little differentiation. Experiments will be repeated with further control treatments for comparison. Preliminary conclusions suggest that growth of *S. tetanopsis in vitro* is strongly pH dependent and optimized somewhere between 5.6 and 6.8. It is not clear how interpretation of these results will extrapolate to saprophytic growth of the fungus in field situations.

Bioassay data indicates that fruit and house fly larvae are not within the host range of this fungus. Similar challenges of ladybird beetles (adults), green lacewings (larvae and adults), sunflower beetles and stem weevils (larvae and adults), tobacco hornworm (larvae), and Colorado potato beetles (adults and larvae) all resulted in a finding of no apparent pathogenic reaction (*i.e.*, infection, colonization, mortality).

The apparent narrow host range of this pathogen may be a distinct advantage from a regulatory standpoint in that an otherwise unknown pathogen with little familiarity to most scientists and scant literature coverage can require extensive testing prior to approval and registration as a biopesticide. Indications from these bioassays are that this fungus is restricted to the SBRM and possible a few other related Diptera.

Appropriate field evaluation of this fungus in a real-world situation will be required to determine if it is worthy of pursuit as a biocontrol agent. Formulation of the fungus with proper carriers and a suitable delivery system are critical to this effort. The parameters that influence this fungus in the soil and its efficacy as a biopesticide are only poorly understood presently. Collaborative efforts have been established with ARS and University researchers to ultimately evaluate this agent under field conditions of high maggot infestations.

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SUGAR BEET RESEARCH

2001 REPORT

Section G

University of Illinois
Urbana, Illinois

Dr. D. R. Bush

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New Strategies for Modfying Sucrose Distribution in Sugarbeet
by Daniel R. Bush.. G3

BEET SUGAR DEVELOPMENT FOUNDATION
Research Report 2002

New Strategies for Modifying Sucrose Distribution in Sugarbeet

Daniel R. Bush
ARS Photosynthesis Research Unit, University of Illinois, Urbana, Illinois

The goal of this project is to increase sucrose storage in the taproot using two different approaches. Research this year focused on our recent discovery of a control pathway that regulates sucrose loading into the vascular system in the leaf (Chiou and Bush 1998). The vascular system mediates the long distance transport of sucrose from the photosynthetic cells in the leaf to the sucrose storage cells in the tap root. This was a very significant finding because loading the vascular system for sugar export from the leaf is the key step that determines how much sucrose is delivered to the tap root. Defining the biochemical steps involved in controlling sucrose distribution to the beet will allow us to develop novel strategies for manipulating productivity (Bush 1999). The second approach for enhancing sucrose content is to test the hypothesis that directed expression of a hyperactive sucrose transporter in transgenic sugar beet can increase sucrose accumulation in the beet. Unfortunately, the technology for generating transgenic beet is not as robust and/or broadly available as expected, and that has become the rate-limiting step for completing this experiment.

Recent Progress

The objective of our investigation of the regulatory system that controls sugar export from the leaf was to identify the biochemical steps involved in modifying the sucrose transporters ability to load the vascular tissue of the plant. Our initial analysis of this system showed that it controls sugar allocation between photosynthetic tissues and "import-dependent" organs like the beet tap root (Chiou and Bush 1998). Using Western blot analysis, we showed that down regulation of sugar transport activity is the result of protein degradation where the transporter is removed from cells that load the leaf vascular system. In parallel with its turnover, we used nuclear run-offs to show that decrease transporter-mRNA abundance is the result of down-regulation of gene expression. Additional experiments showed that both transporter protein and mRNA turnover very quickly (T1/2 = 2 hr). This is a hallmark characteristic of a tightly regulated biological process. Thus, it appears that dynamic regulation of sucrose transporter abundance in the vascular system controls sugar allocation.

This year we showed that a protein phosphorylation signaling pathway plays a key role in regulating the expression of the sucrose transporter gene. As soon as we made that determination, the next question we faced was determining whether the phosphorylation pathway is linked directly with sucrose-mediated regulation of the same gene, or are these independent control systems. To examine the relationship between these two regulatory pathways, we used an inhibitor to block the protein phosphorylation pathway and then we asked if this had any affect on sucrose-mediated signaling. We discovered that the phosphorylation inhibitor completely blocked sucrose signaling as well, thus tying protein phosphorylation to the sucrose-signaling cascade (Fig. 1 below). Our working hypothesis is that the sucrose-signaling system controls sucrose allocation to the tap root by altering the capacity of the leaf vascular system to load sucrose and transport it to the root.

Sucrose Sensor → Protein Phosphorylation

↓

Sucrose Transporter Abundance ← Regulation of Sucrose Transporter Gene Expression

↓

Capacity for Sucrose loading into the vascular system

(Figure 1)

Recent Publications

Coruzzi G and Bush DR 2001. Nitrogen and carbon nutrient and metabolite signaling in plants. *Plant Physiol* 125: 65-68

Chen L, A Ortiz-Lopez, A Jung, and DR Bush 2001. ANT1, an aromatic and neutral amino acid transporter in Arabidopsis. *Plant Physiol* 125:1813-1820

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